5-2001

Ten Thousand Years of Population Relationships at the Prairie-Woodland Interface: Cranial Morphology in the Upper Midwest and Contiguous Areas of Manitoba and Ontario

Susan Mary Myster
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Susan Mary Myster entitled "Ten Thousand Years of Population Relationships at the Prairie-Woodland Interface: Cranial Morphology in the Upper Midwest and Contiguous Areas of Manitoba and Ontario." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Richard L. Jantz, Fred H. Smith, Major Professor

We have read this dissertation and recommend its acceptance:

Charles H. Faulkner, Lyle W. Konigsberg, David A. Gerard

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

We are submitting herewith a dissertation written by Susan Mary Thurston Myster entitled *Ten Thousand Years of Population Relationships at the Prairie-Woodland Interface: Cranial Morphology in the Upper Midwest and Contiguous Areas of Manitoba and Ontario*. We have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Richard L. Jantz, Major Professor

Fred H. Smith, Major Professor

We have read this dissertation and recommend its acceptance:

Accepted for the Council:

Interim Vice Provost and
Dean of the Graduate School

TEN THOUSAND YEARS OF POPULATION RELATIONSHIPS AT THE PRAIRIE-WOODLAND INTERFACE: CRANIAL MORPHOLOGY IN THE UPPER MIDWEST AND CONTIGUOUS AREAS OF MANITOBA AND ONTARIO

A Dissertation
Presented for the
Doctor of Philosophy Degree
The University of Tennessee, Knoxville

Susan Mary Thurston Myster
May 2001

DEDICATION

This dissertation is dedicated to James, Erik, Katie, Mom, and Dad,

my husband, children, and parents,

who have given me unwavering love, support, and encouragement

♥♥♥

ACKNOWLEDGMENTS

As the completion of my graduate education draws ever closer, I find myself reminiscing about my years in residence at the University of Tennessee - the friends (now colleagues) I made, the professors who generously and graciously shared their experiences and knowledge with me, and the many opportunities I was afforded through the Department of Anthropology. There are many people to thank as a result of all of that I gained and accomplished as a student, as well as for the continuing collegiality with many of my friends and professors. First, I would to like to thank Dr. Fred H. Smith, my academic advisor and co-chair of this dissertation. Your continuing support of all my undertakings, from class projects, thesis and dissertation research, to the shift from student to teacher, has provided me with the confidence and experience to begin my own professional and academic career. Your willingness to continue to act as my advisor and mentor for years after you left the University of Tennessee goes well beyond the call of duty and is greatly appreciated. Dr. Jantz, you have also had a tremendous impact on the development of my research interests and my personal growth as a biological anthropologist. As co-chair of my dissertation committee, you have been instrumental in the completion of this research through your constant support and advice throughout the project, as well as your willingness to take care of the significant, yet tedious, paperwork necessary for the completion of the dissertation. I am very grateful for all of the letters, phone calls, and support you provided; I could not have finished this without you! Many thanks also go to the rest of my committee: Dr. Charles H. Faulkner, for his continual

interest in this research, willingness to do so much on such short notice, and his encouragement during the last push of this project; Dr. Lyle W. Konigsberg, for his assistance with and suggestions for the statistical analysis, as well as directing me toward a number of valuable sources on quantitative genetics; and, Dr. David A. Gerard, for agreeing to act as the outside member and suggesting changes in text and tables that clarified the information presented.

Thanks are also extended to a number of other University of Tennessee, Knoxville faculty and staff members who have been instrumental in my graduate education and the completion of this project. Dr. William M. Bass has offered continual encouragement during the completion of this research and wrote letters of introduction and recommendation to a number of Forensic Pathologists working in Minnesota. Dr. Gerald F. Schroedl offered friendship and insight into archaeological theory and contemporary issues. Donna Patton, departmental secretary, was always happy to hear from me and performed magic relative to vital forms on the day of my oral defense.

Access to collections of human skeletal remains was vital to the success of this dissertation. Sincere gratitude is offered to Dr. John A. Williams (University of North Dakota), Dr. E. Leigh Syms (Manitoba Museum of Man and Nature), Dr. Chris Meiklejohn and Mr. Jeff Wyman (Univerisity of Winnipeg), Drs. Douglas W. Owsley and David Hunt (Smithsonian Institution), Ms. Peta Danielson (Royal Ontario Museum),and Ms. Shirley Schermer (Office of the Iowa State Archaeologist/University of Iowa), who were all very welcoming and helpful during my visits. A special note of thanks is given to Dr. John A. Williams and Dr. E. Leigh Syms who graciously opened their homes to me during my data collection trips, and Ms. Peta Daniels who offered to

show me around Toronto. Additional cranial data were generously provided by Dr. Patrick J. Key (The Key Company, Ltd.) and Dr. Richard L. Jantz (University of Tennessee, Knoxville). Finally, I offer my thanks and great respect to Mr. Earl "Buck" Sargeant, Mr. Jim Jones, Mr. Joe Day, and Mr. Roger Head, all of the Minnesota Indian Affairs Council, for allowing and facilitating the study of all repatriated American Indian remains in Minnesota. Thanks also go to Dr. Guy Gibbon, Dr. Christy A.H. Caine, Mr. Grant Goltz, and Dr. Scott Anfinson who offered their expertise in deciphering the culture history of Minnesota's pre-Contact past, as well as their insight and experience in understanding the intricacies of the cultural systems and patterns of interaction. Financial support for a portions of this research was supported by a Sigma Xi Grant-in-aid-of Research. Kudos to the folks at the North Dakota and South Dakota Offices of the State Archaeologist for information and references on various sites.

A debt of gratitude is owed to my good friends and supportive colleagues and dedicated undergraduate students at Hamline University who suffered through what seemed, at times, a never-ending project. Kate Blue (Is it time for a black olive and pepperoni pizza at Old Chicago yet?), Marcia Regan, Val Cervenka, Karen Runyon, Susan Roe, Joel Kohout, Greta Friedemann, Maria Liston, Gretchen Nelson, Tony Falsetti, Tal Simmons, Mike Green, Lori Goebel, Michelle Zirbes, and Ann Kakaliouras deserve special mention for their unwavering support. I have been very fortunate to have had the pleasure of teaching and doing collaborative research with so many dedicated and gifted students. Many of them have assisted me throughout this undertaking providing assistance in typing tables, finding references, and creating charts and figures. Deserving of my sincerest gratitude are Carrie Wright ("table queen"), Chris

Evans (for transforming my rough sketches into beautiful figures and scatterplots), Lori Jahnke, Andy Scherer, Sara Backowski, Carrie Andresen, Jennifer "Scrappy" Dempich, Erin Kimmerle. Thanks to Katina Krull, our secretary, for early typing and formatting of tables. To my colleagues in the Anthropology Department - Van, Liz, Skip, Phyllis, Cynthia, and Karen - I offer many thanks for endless support and encouragement; now I can stop obsessing. Finally, a very special note of appreciation goes to Barbara H. O'Connell for all she has done. As my undergraduate advisor and mentor, she nurtured my interest in the study of human remains and acted as a role-model for ethical and respectful treatment of the remains; currently, as my colleague, she has offered support, encouragement, opportunities, and friendship in too many ways to list here.

Lastly, my family. No words can express my appreciation and wonder at the many sacrifices my family has made in order to ensure that I completed this dissertation and received a Ph.D.. James: Thank you for always supporting my endeavors, encouraging my career, supporting me emotionally and otherwise, and, most of all, for taking care of our children-- making dinners, doing the laundry, doing the grocery shopping, etc. all those weeks, evenings, and weekends I was out collecting data and writing. Erik and Katie: Mom is coming home and she is ready to play!! Mom and Dad: Yes, I finally finished the darn thing, and, yes, I really mailed it off. Thanks for all your love, encouragement, and enduring belief in my abilities. Denise: Thanks for the phone calls and keeping me going; Craig: Thanks for always being proud of your little sister. Cary, Dorothy, Robin, Tim, Sam, Paul, and Sue: Thanks for your support, and the many times you all helped us by taking care of Erik and Katie - - they loved every minute of it.

All right, all right, I'm done.

ABSTRACT

Prehistoric Minnesota was characterized by significant cultural and environmental diversity. Throughout much of its 10,000 year history, this region has witnessed the interaction of human populations with their physical environment, developing adaptive strategies to effectively utilize the resources distinctive to this area. Archaeological research has focused on reconstructing the culture history and the nature and extent of relationships between contemporaneous archaeological manifestations and across major environmental biomes. The research presented here applies a bioarchaeological perspective to the investigation of past population relationships through the integration of archaeological and osteological data. This approach facilitates a more holistic understanding of human interaction in this region during the past 10,000 years of human history.

A multivariate discriminant function analysis was conducted on a large sample of human crania recovered from sites dating from the Early Prehistoric to the Historic period in Minnesota and surrounding border areas in Ontario, Manitoba, North Dakota, South Dakota, Nebraska, and Iowa. A series of 41 measurements, representing the major cranio-facial functional complexes, was taken on 380 crania. Interpretation of results provided insight into the degree of genetic continuity among groups, biological homogeneity of defined archaeological cultures and burial complexes, and evaluation of proposed transformation models.

Results indicate overall biological continuity between Paleoindian, Archaic and Initial Woodland groups. Significant biological discontinuity between Late Woodland

groups and the populations of the Middle Missouri Initial variant, Oneota, and Mississippi traditions suggests in-migration of various populations during this time. The Late Woodland Blackduck phase and the Arvilla and Devils Lake - Sourisford burial complexes exhibit significant biological heterogeneity while the Oneota, Mississippi, and Middle Missouri traditions are more homogeneous. This distinction is most likely due to the more sedentary settlement-subsistence pattern of the southern horticulturalists and the continuation of the more mobile lifestyles of the northern groups despite documented increases in population sizes, intensive collection and reliance on wild rice, and other socio-political practices characteristic of transformation to a tribal pattern of socio-political organization. Results further indicate no definitive ancestor - descendant relationships between late prehistoric archaeological manifestations and resident historic tribal groups. These results may reflect the coalescence of many different tribal communities as a result of the effects of European colonization including disease, forced relocation to military forts and reservations, and manipulation by fur-trade companies to better pursue their own economic interests.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

PI	Paleoindian
EAA	Early Archaic
EAR	Eastern Archaic
PAR	Prairie Archaic
IWD	Initial Woodland
SON	Sonota
WD	Woodland
LW	Late Woodland
BDN	Blackduck, North
BDS	Blackduck, South
NAR	Arvilla, North
SAR	Arvilla, South
DLS	Devils Lake - Sourisford
GRO	Great Oasis
MCR	Mill Creek
CAM	Cambria
BST	Big Stone
BE	Blue Earth, Oneota
ORR	Orr, Oneota
VBL	Vermillion Bluff, Oneota
SIL	Silvernale, Mississippian
ASB	Assiniboine
CH	Cheyenne
CR	Cree
MDE	Mdewakanton
OGL	Oglala
OJB	Ojibwa
SAN	Santee
SSW	Sisseton - Wahpeton
SX	Siouan
TET	Teton
YKT	Yankton
WIN	Winnebago/Ho-Chunk

CHAPTER 1

INTRODUCTION TO THE STUDY REGION AND PRESENTATION OF THE RESEARCH OBJECTIVES

Traditionally, the precontact period in the Upper Midwest has been characterized in less than glowing terms by archaeologists. Bennett (1952:108), for example, summarizes his general perception of this region: "Of the various regional provinces of eastern United States archeology, the northern Mississippi Valley perhaps is least deserving of the appellation, 'glamorous'. Up there are found no important and mysterious hints of Middle American influences; no cross-dating with Pueblo pottery; no vast towns with ceremonial plazas and elaborate temple mounds; no large and complex cultural remains of the classic stature of Ohio Hopewell or southern Middle Mississippi." Unfairly disparaged and prematurely dismissed over the years, the region has attracted only limited attention in national and international archaeological circles. It has become clear, however, to those who dedicate their careers to the reconstruction of past cultures and lifeways in North America, that this region, with Minnesota at its center, is worthy of serious study. Research is showing that the ancient peoples who inhabited this region were anything but refugees of the larger, more complexly organized chiefdoms that dominated life in the Ohio River Valley and central Mississippi Valley in the Middle to Late Prehistoric periods. They were not struggling to implement the dominant lifeways practiced in the "core", but, in fact, were developing unique adaptations to the complex social and physical environments at the "peripheries" of these core areas and selectively

adopted material traits and social practices to suit their needs.

The Upper Midwest is today recognized as one of the most diverse areas in North America. The richness of the cultural and environmental landscape existed in the pre-European contact period as well. The center of the region, encompassed by present-day Minnesota, has been eloquently characterized as a land of contrasts and extremes, "of frontiers and boundaries, both natural and cultural" (Benchley et al. 1997:21). The physical environment displays this great diversity and is a reflection of the state's climatic, geologic, and glacial history. Within its borders two physiographic provinces are recognized, the Superior Upland province of the Laurentian Upland division and the Central Lowland of the Interior Plains division (Fenneman 1938). These provinces, coupled with other factors including climate, affect the nature and distribution of vegetation and faunal communities and define the area as "a transitional one between typically northern forest regions and more southerly prairie-open forest country" (Bennett 1952:108).

Natural resources are varied and abundant throughout the region. Three general vegetation zones dominate the region and include the mixed Conifer/Hardwood Forest, the Deciduous Forest, and the Tallgrass Prairie (Figure 1-1). Symbiotic with the vegetation zones are the Hudsonian and Illinoisan biotic provinces that define the flora and fauna characteristic to this region. Thousands of natural lakes, four major rivers (Mississippi, Red River of the North, Minnesota, Missouri), and numerous smaller rivers and streams see to it that there is no shortage of water resources for plants or animals.

The ancient upper Midwest was also an area of significant cultural diversity.

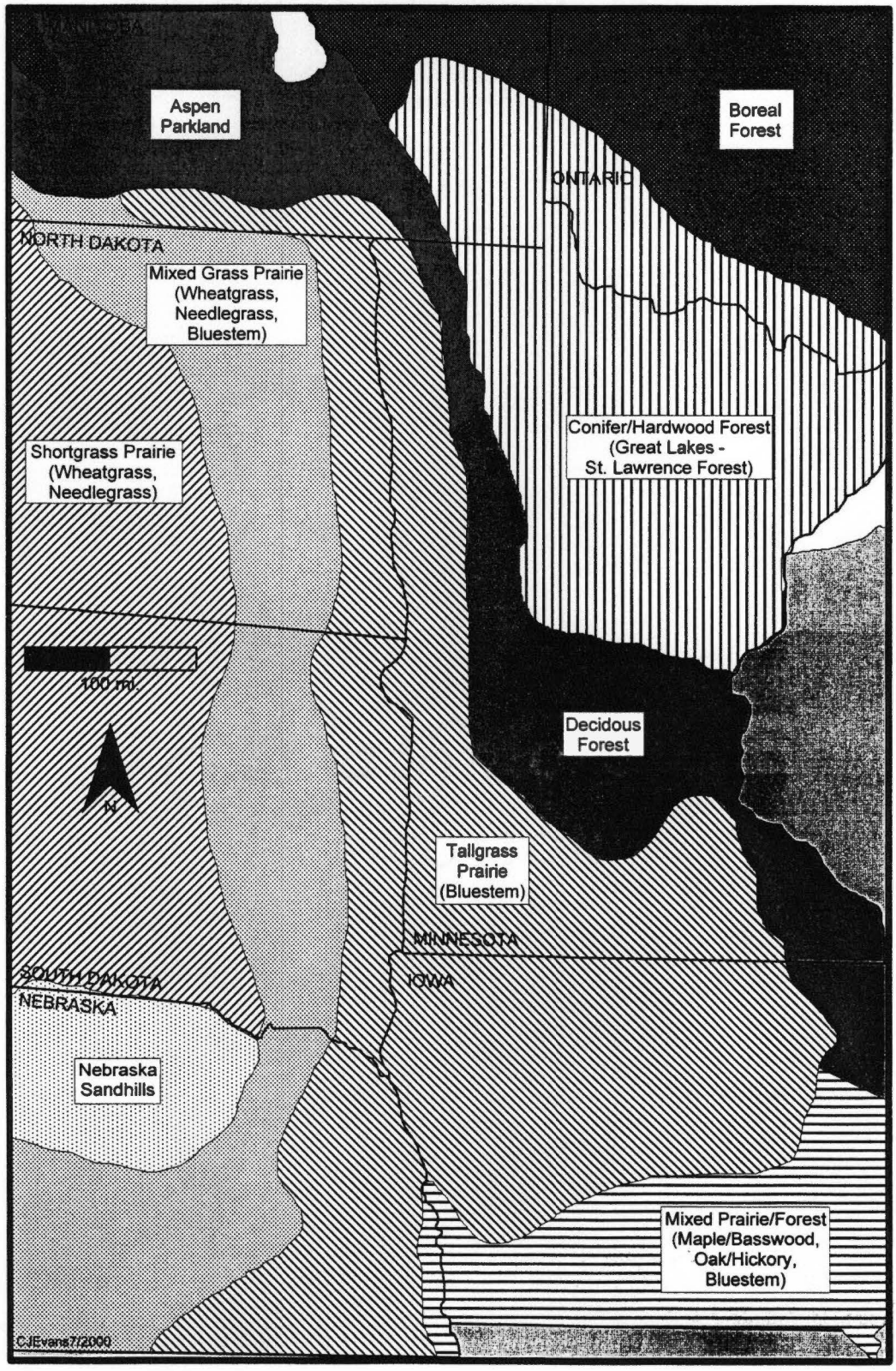


Figure 1-1. General Vegetation Zones Within the Study Region.

Populations on the frontiers of three major "culture areas" lived as neighbors throughout much of the 10,000 year occupation of this region. The western boundary of the study region is included in the Northeastern Plains subregion of the Great Plains (Lehmer 1971a; W. Wedel 1971). The central and southeastern portion of the region, characterized by deciduous forest, represents the western boundary of the Eastern Woodlands (Griffin 1964). Finally, the mixed lake-forest area of north-central and northern Minnesota comprises the northwestern boundary of the Great Lakes area (R. Mason 1981). The archaeological complexes identified for each culture area of the state reflect varied adaptations to the diverse social and physical environment.

Understanding the nature of the relationships between the different populations distributed throughout the study region has been the focus of much archaeological and ethnohistorical research. Certainly significant advances have been made toward illuminating the unique adaptations and interactions of the precontact occupants of the study region (Anfinson 1987, 1997; Benchley et al. 1997; Birk 1977; Caine 1974; Hohman-Caine and Goltz 1999; Dobbs 1984, 1988a; Gibbon 1974, 1989, 1991, 1994; Johnson 1969, 1973, 1991; Michlovic 1983,1990), however, significant gaps in knowledge preclude a more holistic understanding of the archaeological complexes identified. Most significant is the virtual absence of any integration of information derived from the human remains associated with archaeological sites or those recovered from unassociated mortuary sites (Myster and O'Connell 1997). When human remains have been considered, the information reported consists of only the most basic descriptions of burial protocol (primary/secondary burial, position of body, presence/absence of grave goods, pit/non-pit burial, location of burials, number of

individuals interred) (cf. Anfinson 1997; Dobbs 1988a), estimates of the demographic profile of the sample (most often provided by individuals not sufficiently trained in human osteology and skeletal biology) (Wilford 1970; Wilford et al. 1969), or osteological reports relegated to the appendices of site reports (O'Connell 1981).

To be fair, it should be noted that until recently few substantive bioarchaeological studies had been completed and/or published (cf. Myster and O'Connell 1997). As such, few Minnesota archaeologists have sought to include a bioarchaeological perspective when interpreting archaeological sites with associated mortuary components, defining archaeological complexes, or reconstructing regional culture histories. Some exceptions that at least make notable mention of bioarchaeological analyses and interpretations include Johnson (1973), Mather (2000), and Thomas and Mather (1996).

Compliance with the provisions of the Native American Graves Protection and Repatriation Act (NAGPRA), Public Law 101 - 601 (from 1997 - present), as well as the preceding Minnesota Human Remains Reburial Project (1990 - 1996), has resulted in the extensive and systematic collection of osteological data on a majority of all prehistoric and historic skeletal collections in Minnesota. The potential contribution of these data to the understanding of the ancient past is enormous. Analysis of the existing data will expand what is known of each and every archaeological unit in the state for which human remains were excavated (see Dobbs 1988a, 1988b for a thorough consideration of the gaps in existing knowledge of defined archaeological units and Myster and O'Connell 1997 for the same relative to the analysis and interpretation of the associated human remains samples).

Data collected as a result of NAGPRA and the program of reburial in Minnesota

form the basis of the current study and are used to achieve a more holistic understanding of the human populations that once inhabited Minnesota and surrounding border areas. A logical and necessary first step toward this understanding must be an evaluation of the defined archaeological units and an understanding of the patterns of interaction across the various culture areas and biotic/vegetation zones from a biocultural perspective. This dissertation focuses on this area of inquiry by integrating the results and interpretations of a multivariate discriminant function analysis of craniometric data collected from skeletal samples throughout the study region with current archaeological interpretations of the area's prehistory and history.

The data were used to examine traditional archaeological interpretations on three levels. First, an assessment of intragroup homogeneity tested the biological cohesiveness of previously defined archaeological units (e.g., Blackduck, Oneota, Arvilla). Particular attention was paid to the critical question of whether, and to what degree, an archaeological unit equals a biological population (Blakeslee 1994). Secondly, a biological distance analysis provided insight into the nature of the genetic interaction between groups, population migration patterns, and ancestor-descendant relationships between prehistoric populations and historic tribal groups known to or hypothesized to have inhabited the study region. And finally, the results of the multivariate analysis of the craniometric data provided a means of evaluating competing hypotheses and transformation models proposed to explain patterns of population interaction within a culture-historical and evolutionary framework.

The study area under consideration in this dissertation is defined in part by the settlements and migrations of the precontact and historic indigenous populations that

made their homes in the region currently within the state boundaries of Minnesota and the border regions in adjacent states and Canadian provinces. These include northern Iowa, northwestern Nebraska, western North and South Dakota, southeast Manitoba, and southwest Ontario (Figure 1-2). Archaeological research conducted over the past several decades has illuminated the importance of the study region to understanding North America's past. For example, the region represents one of the longest, continuous, and uninterrupted indigenous occupations in North America. The earliest known sites in Minnesota date to approximately 10,000 B.P., and European contact occurred quite late (ca. A.D. 1630) relative to other areas of North America. Additionally, the region contains a variety of ecological systems, including prairies, prairie-lakes, gallery forests, deciduous and coniferous forests, and aspen parklands, all variously affected by the watersheds of the four major river systems. The presence of such diverse ecosystems and the abundant natural resources of the area provide a rich and interesting natural laboratory for the study of human strategies of cultural and biological adaptation during the length of precontact occupation in the study region.

To illustrate, the region under study, centered around Minnesota, is believed to be the original homeland of peoples that later migrated onto the Great Plains. "... (I)t is evident that a careful historical study of the territory embraced in what is now central Minnesota would considerably illuminate our knowledge of the northern Plains tribes. It is evident that many of them took their departure into the Plains from this neighborhood" (Swanton 1930:160). Furthermore, significant lifestyle changes, including the technologies of ceramic manufacture, mound construction, and intensification of food production and collection are believed to have originated here and diffused north and west to the

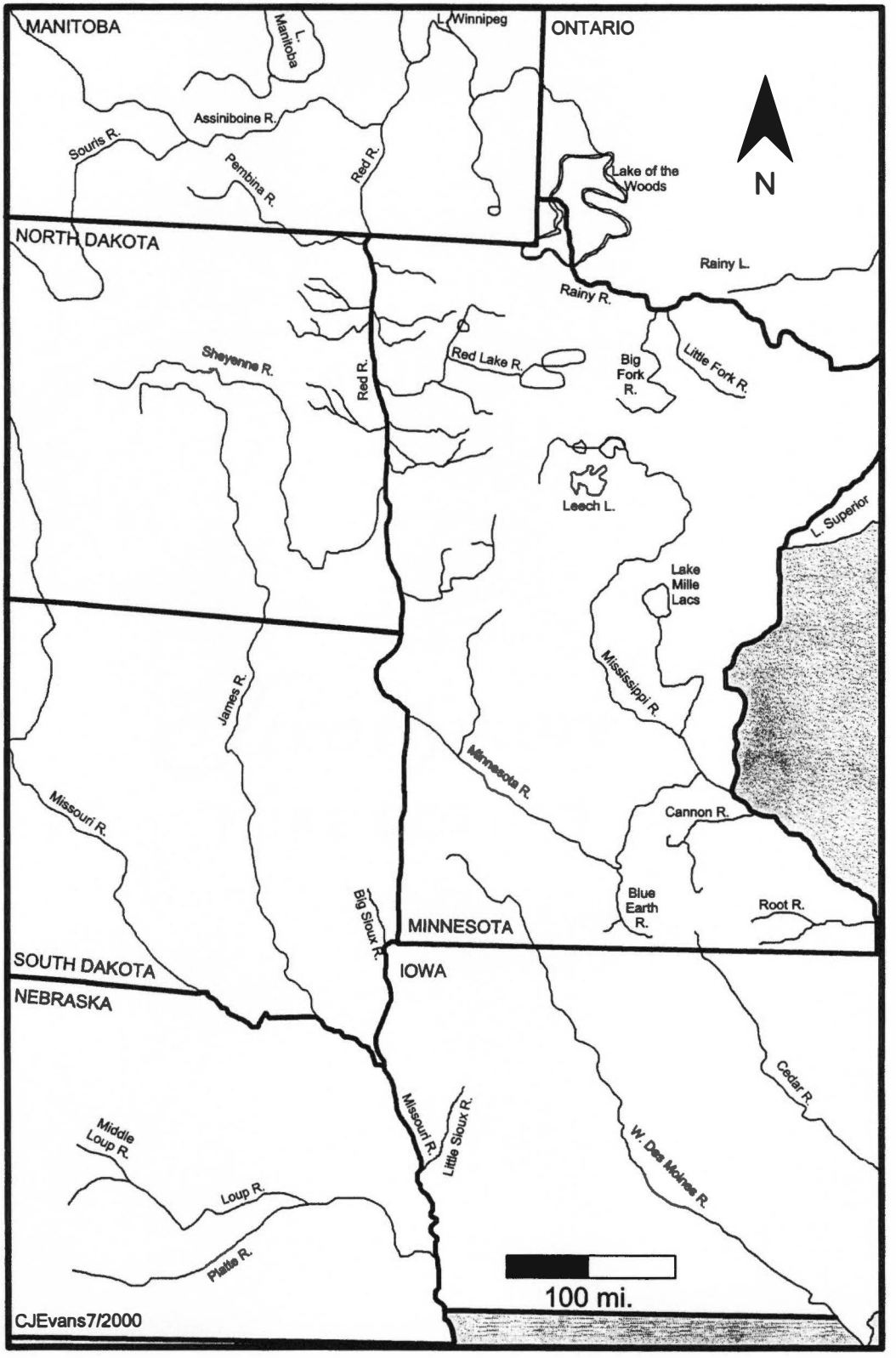


Figure 1-2. The Study Region.

areas of the Great Plains of the central United States and the Boreal Forest of central Canada (Gibbon 1994). The emerging picture of past cultural life ways is one characterized by populations, though located in the territories peripheral to the more socio-politically influential cultural centers, establishing unique adaptations to the physical and social environments.

Cranial measurements were used as the basis for the current biodistance analysis and, in fact, have been utilized in reconstructing culture-historical relationships in many areas of the world (Droessler 1981; Glenn 1974; Heathcote 1986; Hemphill 1998; Howells 1973, 1989; Jantz 1973; Key 1983; Rightmire 1970; Wilkinson 1971) . Their applicability to questions directed at evaluating biological differences between human populations is based in the reliability of phenotypic traits to reflect quantitative genetic information (Konigsberg and Ousley 1995). Pertinent to this is the partitioning of phenotypic variation between genetic factors and those due to the environment. Research has highlighted that although cranial measurements are affected by environmental factors, they have a reasonably high genetic component and, therefore, can effectively serve as a basis for biological distance analyses (Cheverud et al. 1979; Osborne and DeGeorge 1959). Furthermore, when care is taken during measurement selection, considering the effect of nongenetic factors such as climate, activity, and biomechanical effects (Brace et al. 1990; Howells 1969), consistency with information derived from archaeological and historical data is common (Larsen 1997).

A selection of 85 cranial measurements representing various craniofacial functional complexes (Howells 1973; Moore-Jansen and Jantz 1986) were taken on 306 individuals recovered from 75 archaeological sites spanning the 10,000 year history of the study

region (Figure 1-3). The individuals included in the analysis represent many of the currently defined archaeological complexes affiliated with the Great Plains, Eastern Woodlands, Great Lakes culture area adaptations and historic tribal groups believed to have occupied or utilized the study area. Statistical results of the skeletal data were evaluated from a multidisciplinary focus incorporating knowledge derived from archaeological, linguistic, and ethnohistorical data to provide a holistic, bioculturally based interpretation of the development, migration patterns, and interaction of populations occupying this complex area of intersecting sociopolitical manifestations and environmental systems.

Three preliminary considerations are vital to the validity of any biodistance study, and each must be addressed if the results and interpretations from such studies are to be accurate and subsequently incorporated by archaeologists into reconstructions of past cultural systems. First, what is the reliability of current archaeological classifications of these mortuary sites? These classifications are based upon many years of excavated evidence organized within an overarching archaeological taxonomy. An examination of the reliability of the cultural classification of mortuary sites included in a biodistance analysis is rarely mentioned by biological anthropologists as a factor to consider. However, this is usually the first point of clarification requested by archaeologists when evaluating the potential contributions of biodistance analyses to their area of research (Michlovic et al. 1977; Syms 1982).

Chapter 2 presents a more in-depth summary of the archaeological taxonomies utilized in the study region to date, the slightly revised archaeological taxonomy to be applied in the current study, and a description of the present state of understanding for

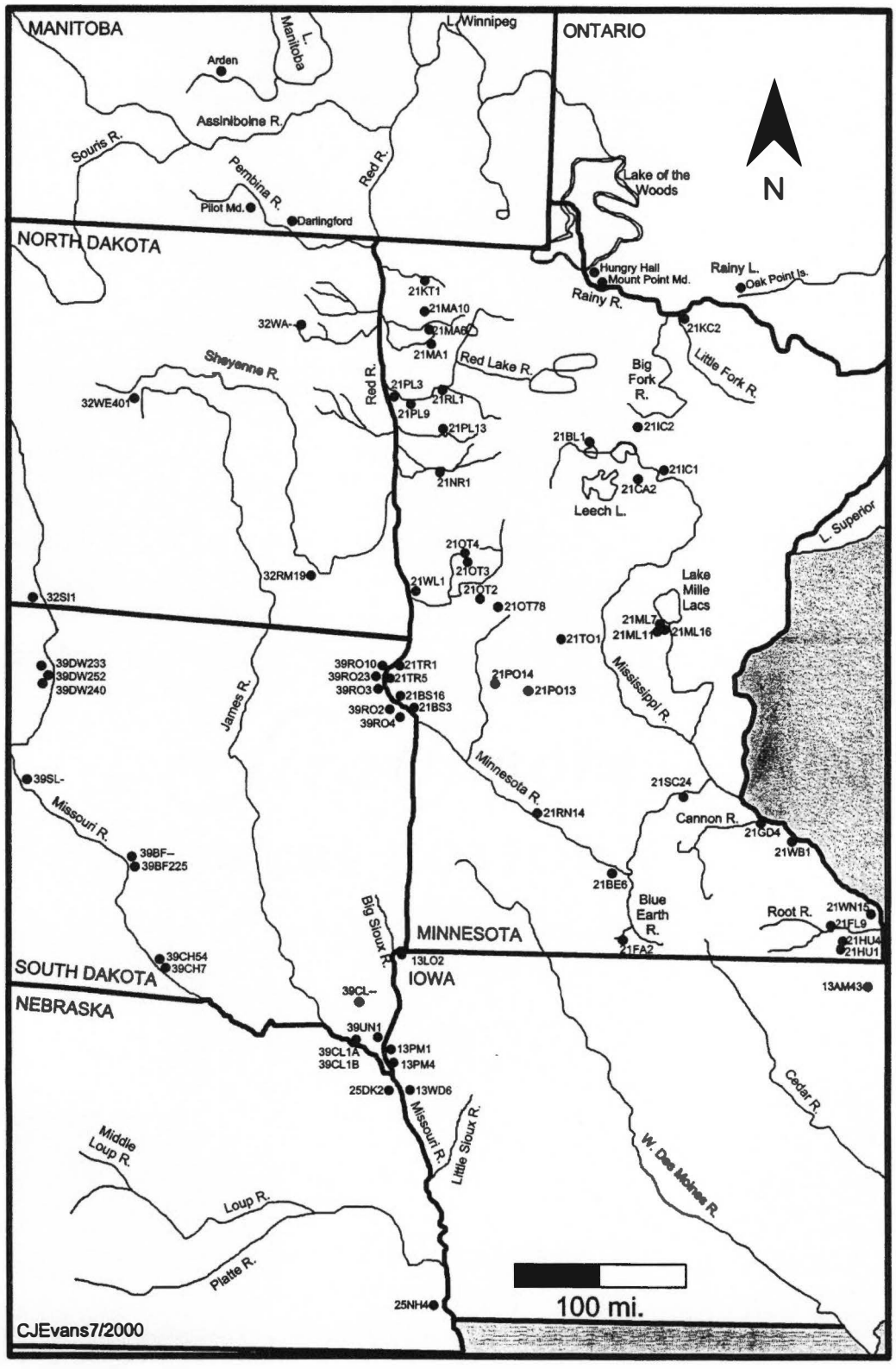


Figure 1-3. Distribution of Sites Yielding Cranial Samples.

each archaeological unit in terms of temporal range, geographic distribution, and evidence for interaction with neighboring peoples. In addition, Chapter 2 describes the physical environment of the study region insofar as it affects human settlement.

Second, the class of data to be used in the analysis must be carefully considered. As mentioned previously, cranial measurements are the data utilized herein. Chapter 3 explores the use of such traits, including issues of heritability, environmental effects, and age- and activity-induced effects. The original measurement set will be presented, as well as the reduced variable set and the reasons behind use of the reduced set.

The method of statistical analysis is the final consideration necessary for assessing reliable results. Given the particulars of the cranial sample utilized here, the method selected for this study is a multivariate discriminant function analysis. Discriminant function analysis facilitates the interpretation of population relationships, identification of the suite of cranial dimensions most important to distinguishing between populations, and the phenetic, and by extension, genetic, homogeneity of each archaeological unit. The methods section of Chapter 3 discusses the appropriateness and advantages of the statistical method of analysis chosen.

The results of the multivariate discriminant function analysis are presented in Chapter 4 through a series of tables and plots reflecting the biological relationships of the samples considered, the particular cranial dimensions that are most significant in determining these relationships, and the accuracy with which each archaeological unit can be reflected metrically. The significance of the results are discussed in Chapter 5 in the context of the current state of knowledge. Transformation models formulated to explain the nature and degree of interaction between populations are evaluated. Results

from this study indicate that some different patterns of population relationships than those identified by previous researchers exist. As such, these findings may contribute to the revision of the current archaeological framework. For example, it is hypothesized that the origins of the Mill Creek and Cambria phases, early phases in the Initial Variant of the Middle Missouri Tradition, were *in situ* developments as opposed to as a result of the migration of Mississippian peoples from the south. The results of the biodistance analysis will contribute to the likelihood of one scenario over the other based on the distances between the phases of the Initial Variant represented in this study.

A summary of the contributions of the biodistance analysis to the understanding of past population relationships in the study region will be presented in Chapter 6. It is the contention here that the current study provides a significant contribution to the understanding of the dynamic nature of the social environment during the lengthy occupation of this region; the current study expands the geographic and temporal range previously examined by biodistance analyses for portions of the study region (Glenn 1971, 1974; Key 1983; Ossenberg 1969, 1974; Peterson 1963; Scherer 1998). This study also represents the first attempt to examine the population variability and interaction of those individuals residing throughout prehistoric Minnesota and bordering areas from a overtly bioarchaeological perspective. The results are interpreted in light of existing hypotheses and models in an attempt to more holistically understand local adaptations to intersecting environmental systems and socio-cultural diversity, as well as to possible influences from complex chiefdoms to the south and east of the study region.

CHAPTER 2

THE STUDY REGION: LANDSCAPE EVOLUTION, ARCHAEOLOGICAL FRAMEWORK, AND CULTURE HISTORY

A more in-depth description of the study region, including its bio-physical environment, culture history, and the archaeological contextual framework applied herein, is necessary to fully explore the research objectives presented in Chapter 1. Since Minnesota lies at the center of the study region and is the focus of the current research, the following discussion will emphasize the cultural and environmental diversity that characterized prehistoric and early historic Minnesota. The implications of such diversity for interactions, adaptations, migrations, and evolution of the populations that inhabited the region of study from 10,000 years ago until the period of European contact and subsequent colonialism will also be outlined. It will be noted when the character of the border territories differs from that observed in Minnesota.

The Bio-Physical Environment

The physical environment, including floral and faunal resources, fulfills many biological and cultural needs for a human community. For the ancient inhabitants of the study region, the environment provided ample food and water resources, raw materials necessary for material culture needs, travel routes that facilitated access to other areas and communities, landscapes that could afford protection from enemies, and identifiable landmarks for the physical manifestations of religious and/or ideological symbols that reflected the spiritual universe and the myth- and event-based history of a culture. The

natural environment of Minnesota and surrounding areas is notably complex and reflects the intersection of several dynamic natural regions including physiographic provinces, biotic communities, major vegetation zones, and drainage or watershed systems. These natural phenomena result in part from the interaction between the physical geology, glacial history, and climate of the study region. A brief and simplified review of the geologic and glacial history of the state will provide a backdrop from which to understand the distribution of the other natural regions that characterize the study area. Primary sources of information for the following review include Borchert and Gustafson 1980; Bray 1977; Dice 1943; Fenneman 1938; Hazard 1982; Jones and Birney 1988; Leverett and Sardeson 1917; Marschner 1974; Ojakangas and Matsch 1982; Schwartz and Thiel 1954; Sims and Morey 1972; and H. Wright 1972.

Minnesota lies near the geographic center of North America and covers an area of approximately 84,068 square miles (Figure 2-1). It is a state that presents a diversity of land forms that speak eloquently of its geologic history and is rich in natural resources that have sustained human populations for over 10,000 years. Located within its borders lie portions of the watersheds of four of the continent's major river systems, several continental divides, three primary vegetation zones, two biotic provinces, and four sections of two physiographic provinces. The presence of over 15,000 natural lakes, in addition to hundreds of streams and rivers, bestows upon Minnesota the distinction of possessing more acres of water (7% of the total landmass) than any other state (Leverett and Sardeson 1917; Schwartz and Thiel 1954).

Geologic and Glacial History

Significant geological forces affected the landscape encompassed within the study

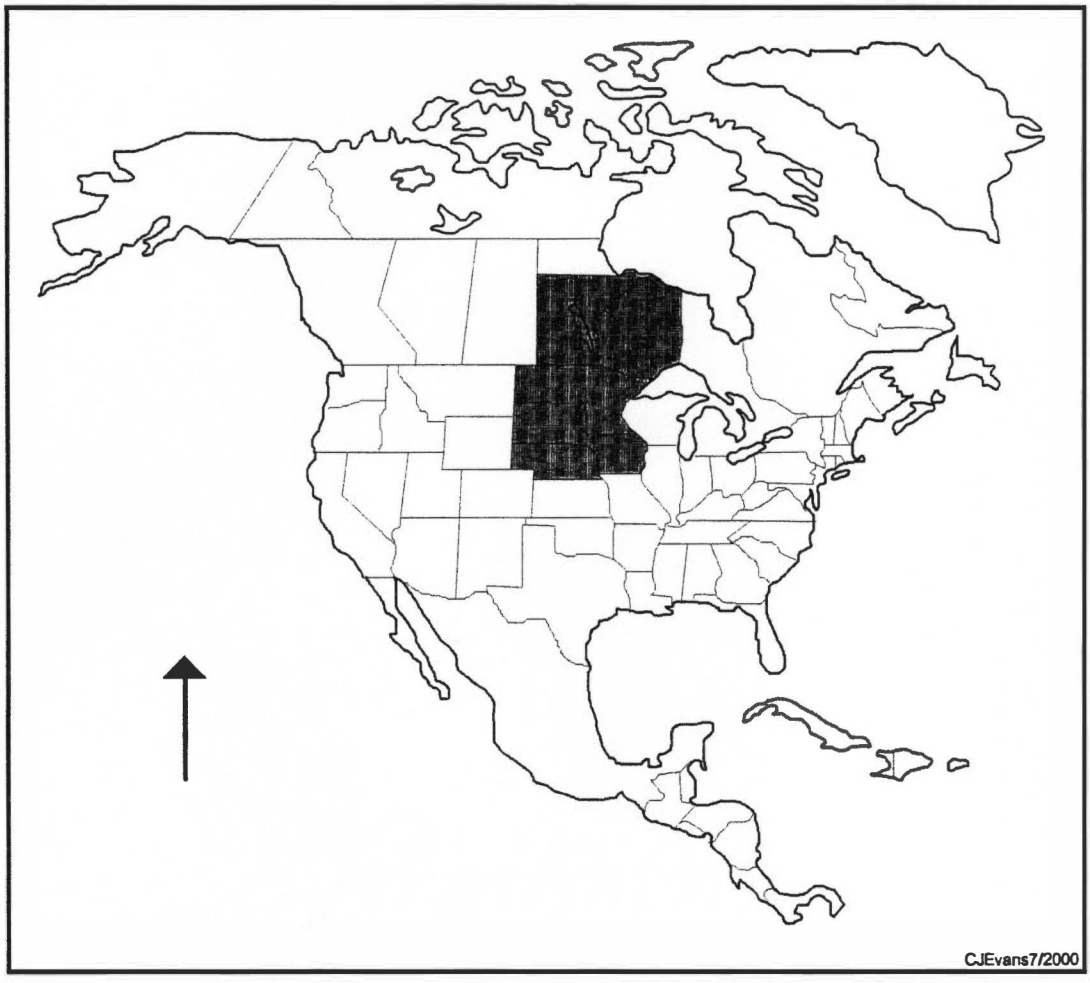


Figure 2-1. Map of the Study Region (highlighted) Within North America.

region during the last 4.5 billion years (b.y.a.). Of primary importance are those that resulted in the deposition of the bedrock formations that lie beneath the soil and the activities that resulted in their exposure and accessibility to human communities. The quality and nature of the various natural resources (e.g., soil, vegetation) that have been important to human populations through time result in part from the rocks that underlie the Earth's surface.

During the Early Precambrian period (4.5 - 2.6 b.y.a) granites and sedimentary rocks were deposited. Later during this period these rocks were transformed into various gneisses as a result of a combination of temperature fluctuations and pressure gradients. Outcrops of some of these ancient gneisses are visible today in the Minnesota Valley. Formation of the bedrock in Minnesota occurred during the Algoman Orogeny (related to mountain formation), a lengthy event that caused a significant deformation in the earth's surface as a result of frequent folding, magma intrusions into the existing bed rock, and surface extrusions as lava. The Middle Precambrian (2.6 - 1.7 b.y.a.) ushered in a period of relative quiet during which existing bedrock was subjected to erosional forces. Two periods of sea expansions resulted in the laying down of thick deposits, the upper levels of which "form bed rock exposed as shales, slates, and mudstones" (Bray 1977:6). The major iron formations of Minnesota were also produced during this period and another orogeny occurred resulting in the formation of additional bedrock. The Late Precambrian (1.7 - 0.57 b.y.a.) saw the formation of the Superior Syncline, a huge depression in what is now the Lake Superior Region. This feature resulted from the formation of a great rift "which split the continent from the Lake Superior Region, through E[astern] Minnesota, to S[outhern] Kansas..." (Bray 1977:6).

The Paleozoic Era (570 - 225 million years ago - m.y.a.) followed the Precambrian and is represented by six periods. The periods are characterized in part by the expansion and retreat of the Epicontinental Sea, the subsequent deposits, and their transformation to various types of rock including sandstones, limestones, shales, green siltstone, and dolomites. During periods when the seas were in retreat and distant from Minnesota, the Precambrian surface rocks were exposed to continual erosional forces.

The Mesozoic Era (225 - 70 m.y.a.) began with the study region above sea level. Factors of erosion continued to act on existing Precambrian rocks and no new rocks were formed. The sea expanded into the northwest corner of Minnesota during the Jurassic Period (195 - 136 m.y.a.) resulting in the formation of shales and gypsum. The sea extended over most of Minnesota in the subsequent Cretaceous Period (136 - 70 m.y.a.) depositing material that evolved into various shales, sandstones, clays, and iron deposits. The sea retreated toward the end of the Cretaceous and the Cenozoic Era (70 k.y.a. - present) saw Minnesota above sea level once again and the surface rocks subjected to a gradual erosion that through the millenia resulted in a land surface with little relief (Ojakangas and Matsch 1982).

Approximately 2 million years ago, during the Pleistocene epoch, the climate in the Northern Hemisphere shifted significantly and the region was subjected to the advances and retreats of massive ice sheets that flowed over most of Canada and into portions of the United States. "The spread of these great ice sheets over vast areas of North America has been the most significant and spectacular event of the Pleistocene epoch on this continent" (Schwartz and Theil 1954:151). Many of the surface features, as well as the topography and relief, present today can be attributed to the repeated glacial events which occurred during what is known as the Great Ice Age.

Four ice stages and three interglacial intervals have been identified during the Pleistocene Ice Age. The movements of the ice sheet during the Wisconsin stage (100,000 - 10,000 B.P.), the most recent, are better understood than those that occurred earlier. Several substages and lobes have been identified and many are responsible for the surface features observable today (Ojakangas and Matsch 1982; Wright 1972). Prior

to the advent of the Pleistocene Ice Age "the surfaces of central North America had been worn to a wide, nearly level plain, a peneplain, well-drained by mature rivers which flowed through broad, shallow valleys" (Bray 1974:15). Following the end of the Wisconsin stage (ca. 10,000 B.P.), the Minnesota landscape was significantly transformed, "characterized by a poorly drained, very irregular surface, with many lakes and swamps" (Bray 1974:15). Numerous land features associated with glaciation including drumlins, ground morains/till plains, glacial lake beaches and lake beds, terminal morains, eskers, and various types of lakes are observable in Minnesota and the border areas that define the study region. Bray (1974) presents excellent descriptions and photographs of these features.

Physiography, Topography, and Drainage

Using Fenneman's (1938) classification system, Minnesota and the remaining territories comprising the study region straddle two of the major physical divisions identified for North America, the Laurentian Upland and the Interior Plains. Most of the state is contained within the Central Lowland province of the Interior Plains, specifically the Western Lake section. Smaller areas of Minnesota, namely the southwestern corner and the eastern portion of the southeastern corner, are assigned to the Dissected Till Plains section. A smaller area in the extreme southeastern corner of Minnesota forms the northwestern extent of the Wisconsin Driftless section. The Superior Upland province represents that portion of the Laurentian Upland division located in the United States and encompasses the northeastern third of the state; the Laurentian Upland has essentially the same borders as the Canadian Shield (Fenneman 1938). Wright's (1972) more recent work on the geologic history of Minnesota has fine-tuned Fenneman's divisions and

provinces by redrawing the borders and more finely dividing the state into 27 physiographic areas.

Each physiographic province, section, and area is defined by the underlying bedrock and associated topography. The study region overall exhibits relatively little relief ranging in altitude from 602 feet (Lake Superior) to 2,230 feet (Misquah Hills in the northeast corner) above sea level. A majority of the state lies at elevations between 1,000 and 1,500 feet. Areas characterized by noticeable relief will be identified during discussion of each physiographic province represented.

The Superior Upland province is characterized by rocks of Pre-Cambrian origin, primarily igneous and metamorphic. The general topography of the province is described as a peneplain with very little relief overall. Fenneman (1938:539) states that although the peneplain is not uniform, "a hill or group of hills, 200 or 300 feet high, is conspicuous and, if the district is inhabited, receives a name." Districts (Fenneman 1938) or areas (Wright 1972) vary in the geologic features and relief present. The northeast portion of Minnesota within the Superior Upland, also referred to as the Arrowhead region, presents the most rugged topography in the study region. Exposure of bedrock formations in the Arrowhead region is not uncommon and many of these were mined for raw lithic material later manufactured into various tools. The well-known "Sawtooth Range", comprised of ridges that border the shores of northwestern shore of Lake Superior, rise 500 - 900 feet above the lake (Leverett and Sardeson 1917; Schwarz and Thiel 1954). Another prominent feature of this region is the Mesabi Iron Range which in some areas reaches an elevation between 400 and 450 feet above that of the surrounding landscape (Leverett and Sardeson 1917).

The Western Lake Section of the Central Lowland province represents the largest portion of the study region. It is underlain by the Precambrian igneous and metamorphic rocks similar to the Superior Upland, Devonian limestones, shales, and sandstone, and Cretaceous shale. Glacial drift, and in some areas, loess are distributed over the bedrock; few exposures of surface rock occur. Topography and relief are distinct from the more rugged surface features of the Superior Upland. Fenneman (1938:572) and others note the frequency of terminal, recessional, and ground moraines in addition to "gravelly, sandy, or swampy plains." Perhaps the most notable features are the extensive lacustrine plain associated primarily with the Glacial Lake Agassiz basin and the prominent beach ridges that document the developmental stages of the lake. Herman beach, for example, "is an impressive feature, traceable throughout the boundary of Lake Agassiz in the United States, and commonly used to define the lake's maximum altitude and extent" (Fenneman 1938:581).

Small areas of the southeast and southwest corners of Minnesota belong to the Dissected Till Plains section of the Central Lowlands. Bedrock includes Paleozoic sandstones and shales, Devonian shales, and Mississippian limestones all overlain by a layer of glacial till. Most characteristic of these two areas are the virtual absence of moraines and lakes and the prominent hills and valleys in the extreme southeast corner (Fenneman 1938; Leverett and Sardeson 1917). This section is also part of a larger loess-covered area, the result of water and wind distribution of very fine till sometimes referred to as "glacial flour" or "rock flour". Loess contributes to the formation of the nutrient-rich, easily tilled soil that has facilitated productive agriculture for over 900 years and characterizes this region of Minnesota. Topographically, notable relief occurs in the

southwest portion of the section as the Coteau des Prairies, the divide between the Missouri and Mississippi drainage basins, which rises 700 - 800 feet above the surrounding plains (Bray 1977; Ojakangas and Matsch 1982; Schwartz and Thiel 1954).

A very small portion of the southeast corner of the state belongs to the Wisconsin Driftless section and is characterized by a rugged topography untouched by any glaciers, or at least by the Wisconsin (Ojakangas and Matsch 1982). The steep valleys and ravines with impressive rock bluffs that provide an extreme contrast to other areas of the state are the result of massive quantities of water runoff from the melting ice sheets cutting through the exposed Paleozoic rocks (Schwartz and Thiel 1954). This is another area of the state that is bereft of natural lakes while being well-watered by rivers and streams. The soil in this region is also known for its quality and productivity.

Many lakes, streams, and rivers traverse the landscape of Minnesota. Four major drainage basins ultimately empty into the Atlantic Ocean. In the northwest part of the state water drains north from the Red River of the North to Lake Winnipeg to the Nelson River to Hudson Bay. The major watershed of the northeast flows east from Lake Superior to the St. Lawrence. Draining the central and southern portion of the state are the Minnesota and Mississippi rivers which flow south to the Gulf of Mexico. Finally in southwest Minnesota water runs off from the Rock River to the Big Sioux, Missouri, and Mississippi rivers south to the Gulf of Mexico (Jones and Birney 1988). The vast water resources provided abundant lacustrine and riverine plant and animal resources that formed a significant component of the diets of ancient peoples. The streams and rivers connected the uplands and lowland areas, facilitating transportation to various ecological regions resulting in access throughout the study region to more than one vegetation

regime.

Vegetation and Biotic Provinces

The surface vegetation supported in an area is the result of the interaction between geology, soils, and climate. For most of the 10,000 years of human occupation Minnesota has been characterized by three major vegetation zones (see Figure 1-1) that together support a wide variety of plant communities (Borchert and Gustafson 1980; Jones and Birney 1988). The geographically intermediate location of Minnesota between three major biomes, the prairie grasslands of the central United States, the deciduous woodlands of the eastern United States, and the boreal forests of southern Saskatchewan, Manitoba, and Ontario is believed to have directly affected the interactions and adaptations of past cultures. The proximity to both the more uniform ecosystems of the defined vegetation zones and the more varied ecosystems of the border areas (ecotones) between them provided early peoples with a wide variety of natural resources to exploit as food, material, and cultural resources (Hazard 1982; Johnson 1988).

The prairie region is located along the northwestern border of Minnesota and the area south of a diagonal boundary running northwest to southeast from the confluence of the Red and Minnesota rivers to the Iowa border. The prairie area extends westward into North and South Dakota and south to cover most of Iowa. The Minnesota, North and South Dakota, and Iowa prairies are tallgrass prairies characterized by big bluestem, little bluestem, goldenrod, and prairie clover (Borchert and Gustafson 1980; Jones and Birney 1988). Projecting into this tallgrass prairie and associated with the Red River, Minnesota, and lower Mississippi rivers in Minnesota and a portion of the Missouri in Iowa is Kuchler's (1964) Northern Floodplain Forest, a gallery forest characterized by

cottonwood, elm, willow, and ash (Hazard 1982; Jones and Birney 1988). This environment, variously intersected by lakes, rivers, and streams, supported a vast array of flora and fauna that was effectively exploited by prehistoric populations (Anfinson 1997).

A deciduous forest angles southeastward from the central portion of the state continuing south along the eastern border of Iowa. This region corresponds to a mixed Oak, Oak Savanna, and Aspen Parkland and Maple-Basswood distribution. The area is intersected with lakes, streams, rivers, and prairies. Important trees include broad leaf trees such as sugar maple and basswood, as well as oak, burr oak, eastern cottonwood, elm, and ash (Borchert and Gustafson 1980; Dice 1943; Sather and Dana 1999). The northern border of the deciduous forest and the northeastern border of the tallgrass prairie abut a mixed coniferous and hardwood forest commonly referred to as the Great Lakes - St. Lawrence Forest. Balsam fir, white spruce, bog conifers, jack pine, red pine and white pine define this biome. It is a more dense and lush forest than the more southern deciduous forest and home to a rich variety of terrestrial and aquatic plants and animals on which human populations subsisted.

The three vegetation zones present in the state support two related biotic provinces, the Illinoian and Canadian (Dice 1943). The southwest portion of the Canadian province is coincident with the mixed deciduous and coniferous area in northeast Minnesota and the Manitoba and Ontario portions of the study region. The climax forest in the Canadian province is hardwood with sugar maple, beech, yellow birch, white pine, basswood, and eastern hemlock. Subclimaxes include pine forests comprised of white and Norway pine and bogs and swamp areas (Dice 1943) where "the vegetation developed over peat and

acid groundwater and included black spruce, tamarack, heaths, and sphagnum mosses" (Borchert and Gustafson 1980:24). Minnesota's northern territory consists of many peat bogs and swamps. The acidic quality of the soil, coupled with less than 100 frost-free days on average, precludes successful crop production.

The borders of the major vegetation regimes are dynamic and have shifted over time as a result of temperature, precipitation, and human intervention. Currently temperatures range from 80 to 100 degrees Fahrenheit in the summer to extremes of -20 to -60 in the winter resulting in frost free days that range from 100 days in northeast Minnesota to between 100 and 200 days in the central portion of the state and between 200 to 300 days in the southwest corner (Jones and Birney 1988). Precipitation in the form of rain and snow ranges from an average of 20 inches in extreme northwestern Minnesota to approximately 40 inches in extreme southeast Minnesota. The majority of the state, however, receives on average 30 inches of precipitation per year. Webb et al. (1983) summarize vegetation shifts over the last 10,000 years. Between 10,000 - 8,000 B.P. the prairie border shifted east reaching its maximum extent in Minnesota by 6,000 B.P. as the region saw maximum post-glacial temperatures. After 6,000 B.P., as a result of climatic cooling, the prairies retreated and the vegetation distribution present today was established.

In summary, the combination of geologic history, physiography, and climate has resulted in an extremely complex, diverse, and rich physical environment. The geologic forces that shaped the current state of Minnesota produced a topography that lacks any significant physical barriers. The vast waterways facilitated travel within and outside the state. Aquatic and terrestrial floral and faunal resources were abundant throughout the

state and adequately supported human populations throughout its 10,000 year occupation.

Archaeological Framework

The first attempt to organize existing knowledge of Minnesota's prehistory into an classificatory taxonomy was presented in 1941 by Lloyd A. Wilford, one of Minnesota's premier archaeologists (Wilford 1941). Wilford cautioned that his taxonomy must be considered tentative due to the paucity of professionally excavated sites in Minnesota and the lack of any in-depth knowledge of any one region within the state. Wilford's taxonomy consisted of only the Woodland and Mississipian periods. Each period presented a distinctive pattern of adaptation that "reflects regional differences without much depth of sequential relationships" (Wilford 1943c:91). The taxonomy was primarily organized on geographic distribution of cultural complexes that appeared to exhibit little overlap. Temporal relationships were hinted at for some regions, Mille Lacs and southern Minnesota for example, but little was known at this time about the temporal relationships between the identified groups. Wilford's classification was organized using McKern's (1939) Midwestern Taxonomic System. Within the Mississippian and Woodland patterns, seven aspects, represented by eight foci and 29 components, were identified (Table 2-1).

In 1955 Wilford revised his taxonomy to reflect advances, both regionally and locally, in the understanding of the prehistoric past. Further archaeological excavation, reports of investigations, and construction of regional cultural sequences "crystallized in a framework in which the 3 major cultural groupings, the patterns, have been fitted [sic]

Table 2-1. Lloyd A. Wilford's 1941 Late Prehistoric Archaeological Taxonomy.

Pattern	Phase	Aspect	Focus
Mississippian	Upper	Oneota	Orr
			Blue Earth
			Humphrey
Woodland	Lake Michigan	Effigy Mound	-----
		Mille Lacs	Kathio
			Howard Lake
		Headwaters Lakes	Blackduck
		Rainy River	Laurel
		Red River	Arvilla Lake Traverse
		Southern Minnesota	-----

Source: Copied in part from Wilford, L.A. (1941:232) A Tentative Classification of the Prehistoric Cultures of Minnesota. *American Antiquity* 6:231-249; Components are not shown.

into a chronological sequence of 4 periods. It is now possible to place the Minnesota cultures in this framework with a fair degree of confidence" (Wilford 1955:130). The most signficant change from the 1941 taxonomy is the addition of a relative temporal framework to the geographic one (Table 2-2). Calendrical time spans are, of course, not

Table 2-2. Lloyd A. Wilford's 1955 Revised and Updated Archaeological Taxonomy.

Period	Pattern	Phase	Aspect	Focus
Late Woodland	Mississippian	Upper	Oneota	Orr Blue Earth Silvernale Cambria
		Plains	-----	Great Oasis
	Woodland	Lake Michigan	Headwaters Lakes	Blackduck
			Red River	Arvilla
			Mille Lacs	Kathio
Middle Woodland	Woodland	Lake Michigan	Mille Lacs	Malmo
			Rainy River	Laurel
			Southern Minnesota	-----
			Effigy Md.	-----
		Hopewellian	-----	Howard Lake
Early Woodland	Woodland	-----	-----	La Moille
Archaic	-----	-----	-----	-----

Source: Copied in part from Wilford, L.A.(1955:131) A Revised Classification of the Prehistoric Cultures of Minnesota. *American Antiquity* 21:130-142; Components are not shown.

provided given the recent introduction of radiocarbon dating at that time. Additional changes included the definition of a Plains phase comprised of the Cambria focus, two additional Mississippian foci – Cambria and Great Oasis, and the Early Woodland La Moille focus. Limited knowledge of several aspects, including the Southern Minnesota and Effigy Mound aspects of the Woodland Pattern, resulted in little clarification of these taxa. Hypothesized relationships within and between several aspects as well as those defined for other states were formulated as well by Wilford and will be discussed in Chapter 6 during a discussion and interpretation ofthe results of the current study.

Further excavation and analysis, as well as widespread availability of radiocarbon dating, resulted in a more sophisticated understanding of local archaeological manifestations and geographic sub-regions (e.g., Laurel, Oneota, Prairie Lakes area, Snake River). In 1969, Elden Johnson, former Minnesota State Archaeologist, presented a general chronology of the four major traditions and summarized the defining characteristics of each as they were understood at the time. Johnson's work was unique in that it was written for a general public audience and also discussed relevant legislation and the growth of public and contract archaeology (see Johnson 1988).

During the last 45 years, many archaeologists have presented refinements of Wilford's (1955) taxonomic scheme for various areas and cultural traditions. (cf. Anfinson 1987,1997; Birk 1977; Caine 1974; Hohman-Caine and Goltz 1995; Dobbs 1984; Gibbon 1986, 1991,1993; Gibbon and Caine 1980; Lenius and Olinyk 1990; Lugenbeal 1976; Michlovic 1983; Stoltman 1973). A more revolutionary revision was presented in 1988 (Dobbs 1988a, 1988b) to reflect the current state of knowledge of Minnesota's prehistoric and early historic past and their distinctive cultural adaptations.

The diversity of ancient human cultures, is in part related to the evolution of cultural systems well adapted to the particular physical environments that characterized the regions they inhabited. Throughout the last 5,000 years the central and southeastern portions of the state has been covered by deciduous forests and the prehistoric populations present in this area expressed cultural features affiliated with the Eastern Woodland cultures situated further south and to the east. The northeastern reaches of the Great Plains extended to the western margin of Minnesota and the cultures settled in this area reflect a plains adaptation characterized by bison hunting. Finally, the mixed coniferous-deciduous forest region of central and northerneastern Minnesota was inhabited by populations that shared similar adaptations with the upper Great Lakes groups settled in eastern Manitoba, southern Ontario and northern Wisconsin and Michigan (Benchley et al. 1997).

The ecological and cultural diversity that characterize the region have implications for the organization of the prehistoric populations into a temporal-cultural framework. As discussed earlier, the populations that occupied the study have long been considered as peripheral settlements or outposts to the culture "cores" of the larger and dominant Great Plains, Eastern Woodlands, and Great Lakes culture areas. The lifeways and interaction of the cultures within Minnesota across the boundaries of each of these culture/biome areas has been a significant research focus of archaeologists. More recently work has recognized the distinctive adaptations of these populations and their selective adoption, or retention, of cultural practices originating from the dominant cultures to the west, south and southeast. The early characterization of Minnesota cultures as peripheral expressions of the core populations in the Central and Souther

Great Plains and the chiefdoms centered in the Middle Mississippi Valley led to the attempts to impose temporal, cultural historical frameworks that were developed for areas quite different environmentally and far removed geographically. Dobbs (1988a, and later in Benchley et al. 1997) and Anfinson (1997) call for a reorganization of the temporal-cultural framework utilized in Minnesota. The merits of the new frameworks are clear and will be presented below in a discussion of the culture history of the study area. The new archaeological contexts will be related to the traditional designations of Paleoindian, Archaic, Woodland, Mississippian, and Oneota. The proposed framework and its discontinuity with the bulk of all substantive published literature preclude a wholesale and unaltered application in the research presented here. All results and subsequent discussion will utilize the older, more traditional temporal-cultural framework with some integration of the new framework when appropriate.

The archaeological taxonomy utilized for this research is an amalgamation of many ideas put forth by many people. The framework presented here is primarily that constructed by a group of professional archaeologists charged with formulating a cultural resource management plan for the State Historic Preservation Office (Dobbs 1988a, 1988b) with modifications based on the culture history of the recently defined Prairie Lakes region presented in Anfinson (1997). A tripartite structure is imposed at the most general level to place the defined phases within three periods, Early, Middle and Late Prehistoric, that encompasses all regions of the state. This is done to clarify the temporal placement of the designated phases in Minnesota for those interested in the culture history of the area but not possessed of a working knowledge of the defined archaeological units. The tripartite system utilized here is based generally on that

presented by Anfinson (1997) with modifications of the temporal ranges in order to encompass archaeological phases outside the Prairie Lakes region.

The archaeological groups defined for the 10,000 year history corresponds closely to the vegetation zones and associated wildlife that have been defined for the state and their changing boundaries. The nature of the groups who inhabited these areas reflects adaptations to these varied environments. The environmental complexity of the study region results in a culture history that reflect unique human adaptations to the frontier areas of the Great Plains, Eastern Woodlands and Great Lakes areas. For example, Dobbs (1988a:40) rejects the term 'Woodland' as a unifying concept for the period during which mound construction and ceramics make their first appearance because a Woodland lifestyle was originally defined in the Ohio Valley to reflect an emerging lifestyle pattern characterized by ceramic manufacture, earthen mound construction, the first use of cultivated plant foods, and a shift to a semi-sedentary settlement pattern. Whereas the emergence of these cultural characteristics appeared at roughly the same time in the Ohio Valley, they do not in Minnesota. "Rather it appears that there is a continuation of an Archaic lifeway with the addition of ceramic production and moundbuilding. There is also an increasing regional differentiation between the material remains of these groups. The term 'Woodland', therefore, seems inappropriate and confusing, particularly when comparing assemblages of archaeological materials to those in other areas of the Midwest." Table 2-3 presents the slightly modified and integrated culture history and archaeological taxonomy for Minnesota presented in large measure by Dobbs (1988a, 1988b), Benchley et al. (1997), and Anfinson (1997). Phases

Table 2-3. Archaeological Framework for the Prehistoric Period.

Context	Temporal Range (B.P.)
Early Prehistoric Period	**Before 3,000**
Paleoindian Tradition	**10,500 - 8,000**
Archaic Tradition	**8,000 - 3,000**
Shield Archaic	Unknown
Lake Forest Archaic	8,000 - 3,000
Prairie Archaic	**5,500 - 2,000**
Eastern Archaic	**8,000 - 2,000**
Middle Prehistoric Period	**3,000 - 900**
Early/Initial Woodland	**2,500 - 2,000**
Fox Lake	2,200 - 1,300
Lake Benton	1,300 - 800
Malmo	2,200 - 1,800
Howard Lake	2,400 - 1,700
Havana-related	2,200 - 1,700
Laurel	2,000 - 1,500
Sonota Burial Complex	**2,000 - 1,400**
Late Prehistoric Period	**1,100 - ca. 370**
Woodland Tradition	
Blackduck	**1,200 - 600**
Kathio	1,100 - 650
Sandy Lake	1,000 - 300
Arvilla Burial Complex	**1,500 - 600**
Devils Lake - Sourisford	**1,100 - 600**
Middle Missouri Tradition - Initial Variant	**1,100 - 700**
Great Oasis	**1,100 - 800**
Mill Creek	**1,100 - 700**
Cambria	**1,100 - 700**
Big Stone	**900 - 700**
Oneota Aspect	**1,000 - 350**
Red Wing Locale	1,000 - 700
Blue Earth	**1,000 - ca. 370**
Orr	**500 - 300**
Mississippian	**1,000 - 600**
Silvernale	**1,000 - 600**

Contexts represented in the study sample are in bold.

in bold-type indicate those for which a sample of human crania was included in the present study. The culture history discussed below is directed toward the archaeological phases represented in the human remains sample and the specific research questions presented in Chapter 1.

The Culture History of Minnesota with Reference to the Surrounding Border Areas

The culture history of the prehistoric, protohistoric, and historic periods in Minnesota reflects the influences on these early populations from the Great Plains, Eastern Woodlands and Great Lakes culture areas. A number of researchers, in an attempt to clarify the culture area adaptational leanings of certain periods and to distinguish them from the Eastern Woodland influenced traditions, have variously added "Plains" as an adjective (e.g., Plains Archaic, Plains Woodland).

The Early Prehistoric Period (ca. 11,500 B.P. - 3,000 B.P.)

The Paleoindian Tradition (ca. 11,500 B.P. - 8,000 B.P.).

This tradition represents the earliest evidence of human occupation in Minnesota. A single individual, the well-known Browns Valley skeleton, represents this taxon and is assigned to the Lanceolate Pattern (Dobbs 1988a). The Lanceolate Pattern postdates the Fluted Point Pattern. Analysis of lanceolate points and site location indicates that this pattern is characterized by increasing regionalization of tool styles and adaptive strategies (Benchley et al. 1997). The Brown's Valley site (21TR05) was discovered in 1933 during gravel mining operations and yielded both a human burial and associated artifacts. Recent AMS dating of a bone sample taken from the left femur yielded a date of 8,790+/-110 B.P. (O'Connell and Myster 1996; Stafford et al. n.d.). Browns Valley is incorporated into the current biodistance study to evaluate its relationship to the Archaic

sample and later skeletal series.

The Archaic Tradition (ca. 8,000 B.P. - ca. 3,000 B.P.).

The Archaic is generally characterized as reflecting a shift from the "big game hunting" settlement and subsistence mode of the Paleoindian Tradition to a more broad-based exploitation of a wide range of locally available plants and animals (J. Caldwell 1958; R. Mason 1981; Tuck 1978). Increased utilization of local resources is also indicated by the materials manufactured by Archaic peoples into various tools, grave goods, and other classes of artifacts. This widespread reliance on local resources exemplifies the trend toward increasing regionalization that appears to characterize Archaic manifestations throughout the Midwest (Anfinson 1997; Funk 1978; R. Mason 1981; Tuck 1978).

The Archaic Tradition is particularly poorly known in Minnesota (Anfinson 1997; Benchley et al. 1997). This situation may be remedied in the near future, however, as more recently excavated sites are analyzed, interpreted, and published. Additionally, a 1996 symposium at the Plains Conference, organized by Dr. Guy Gibbon, focused on the Archaic Tradition; publication of the presented papers may shed new light on the adaptations of Archaic peoples in the study region. Four Archaic Traditions are currently defined for Minnesota: Shield Archaic; Lake-Forest Archaic, Eastern Archaic, and Prairie Archaic. The Shield Archaic is the most poorly represented and least understood Archaic tradition. Initially defined for early sites in Ontario (J. Wright 1972), the geographic extension of this tradition was expanded southward with the discovery of Shield Archaic sites in Minnesota. Few Shield Archaic sites have been excavated but tend to be situated in the coniferous forests of northeastern Minnesota. This area of the study region

overlays the southernmost extension of the Canadian Shield and falls within the Superior Uplands physiographic province (Fenneman 1938). The Lake-Forest Archaic is believed to extend from 8,000 - 3,000 B.P. and known sites are distributed throughout the mixed deciduous-coniferous forests of central and northern Minnesota. This region is often referred to as the Lake-Forest biome due to its high density of lakes, rivers, and streams. It is very likely that the waterways in this region were utilized as travel corridors during much of prehistory. There is some indication that the adaptive strategy that characterizes this tradition is more similar to the groups to the east than to the more proximate Prairie Archaic (see below) groups occupying the prairie region in southern Minnesota. Knowledge about the settlement and subsistence practices is not extensive but exploitation of a wide array of locally available lacustrine and woodland flora and fauna in addition to consumption of large mammals is indicated (Benchley et al. 1997). No Shield Archaic or Lake-Forest Archaic mortuary sites have been excavated and, therefore, these two early traditions are not represented in the study sample.

The Eastern Archaic Tradition is believed to extend from 8,000 - 2,000 B.P. Site distribution coincides with the distribution of the eastern deciduous forest. Adaptation was directed toward utilization of riverine resources for food (deer, nuts, fish) and manufacturing materials (bone, lithic, shell). Given the climatic instability during the Archaic and the resultant shifting of the prairie-forest border throughout its duration, it is likely that there may be a hiatus in the presence of Eastern Archaic sites in the state between 7,000 and 4,000 B.P. when the prairie gradually extended to the central and southeastern border of the state and slowly retreated westward to its present location by 4,000 B.P. Given this situation it is not surprising that only one mortuary site in the study

sample is classified as Eastern Archaic.

The Prairie Archaic is primarily known from sites excavated in the Red River Valley along the northwestern border and the southwest region of the state. Due in part to the dominance of prairie vegetation throughout much of the Archaic in Minnesota, the Prairie Archaic Tradition is the best known of the four Archaic traditions. Prairie Archaic peoples, as is hypothesized for the other Archaic traditions, exhibit increasing regionalization. They relied intensively on bison, although some evidence for exploitation of other resources exist in the form of milling stones, domesticated dogs, and advances in hafting "mechanisms"(Anfinson 1997). Six Prairie Archaic sites yielded sufficiently complete crania to be included in the current study. Included in this sample is the widely known Minnesota Woman skeleton from the Pelican Rapids site (21OT03). Various nicknames have been attached to this skeleton. In order to avoid any misunderstanding, "Minnesota Woman" will be referred to as "Pelican Rapids", the site name.

Interpretation of known Archaic sites paint a landscape occupied by small, mobile hunter/gatherer bands, heavily dependent on locally available resources. The extent and nature of interaction between these migratory bands is unknown, however, a few interpretations may be made based upon existing knowledge. Few nonlocal materials are present in Archaic artifact assemblages suggesting little dependence on long-distance trade networks. Population density is believed to be low due to the size and nature of identified sites, and the paucity of archaeological sites and artifact finds (Anfinson 1997). Analysis of the pathology profiles of human remains recovered from Archaic mortuary sites indicates that interaction was non-violent in nature. Mortuary practices identified

from Archaic sites in neighboring regions in Iowa suggest that mortuary sites were repeatedly utilized over long periods of time by lineal descent groups; possibly indicating land-use patterns defined by "corporate", lineage-based territorial rights (Benn et al. 1992). In contrast, Fisher et al. (1985:215) interpret the Middle Archaic Turin site (13MN02) burial protocol to suggest the absence of "integrative cultural mechanisms such as the periodically constructed ossuaries of the late Archaic period (Lewis Central School) and conical burial mounds of the Woodland period ..." It is possible, then, that increasing regionalization throughout the Archaic is reflected by identification, and perhaps demarcation, of hunting-gathering territories by mortuary sites or "burial stations" that contain the remains of individuals from groups claiming inherited rights to land and resources (Charles and Buikstra 1983; Pfeiffer 1977, 1979).

The Middle Prehistoric Period (3,000 - 900 B.P.)

The onset of the Middle Prehistoric period coincides with the appearance of the Woodland Tradition, a developmental concept formulated to describe archaeological cultures present in the Eastern Woodlands culture area (Griffin 1946; Wissler 1922). The classic expressions of the Woodland period are most frequently encountered in the lower Midwest, particularly in the Illinois and Ohio river valleys. The applicability of the Woodland Tradition cultural-temporal framework to the precontact period of Minnesota has been questioned (see Anfinson 1997; Benchley et al. 1997). Awareness of its limitations as a developmental and theoretical concept for organizing the prehistory of Minnesota reflects an increased understanding of the distinctive nature of the cultures identifiable in the archaeological record during this time.

The Woodland Tradition, as defined for the cultures of the lower Midwest, is

characterized by the first appearance of ceramics coupled with mound construction activities, increased reliance on cultivated foods, a concomitant shift toward sedentism, and an increase in population size (Griffin 1946, 1952). Significant social developments, including the emergence of regional complexes that engaged in extensive trade networks and exerted wide-ranging cultural and political influence, are identifiable throughout the Woodland (e.g., Hopewell). Populations within the Northeastern Prairie region and the western and northern border area of the Eastern Woodlands region do practice some of these cultural developments, however, they do not occur at the same time as in regions to the south and east, nor are the appearance of such traits clearly linked (Benchley et al. 1997). Mound construction appears early in this period, perhaps during the late Archaic, as does ceramic manufacture. The practice of horticulture and increased reliance on cultivated foods occur much later and little is documented for Minnesota sites until approximately 1,000 years ago (Perkl 1998). Related to this, populations remain small, widely scattered and more mobile until the adoption of maize horticulture in the southern and south-central areas of the state and intensified utilization of wild rice in the north and north-central areas ca. 1,000/1,100 B.P. (Anfinson 1997; Gibbon 1994; Johnson 1988).

Figure 2-2 illustrates the distribution of known Middle Prehistoric archaeological units.

Early Woodland (ca. 2,500 - 2,000 B.P.).

The Early Woodland is generally defined for the Midwest by the first appearance of ceramic vessels. Ceramic wares are characterized during this early period by their overall thick walls and cordmarking surface treatment (Fayette and Marion Thick). La

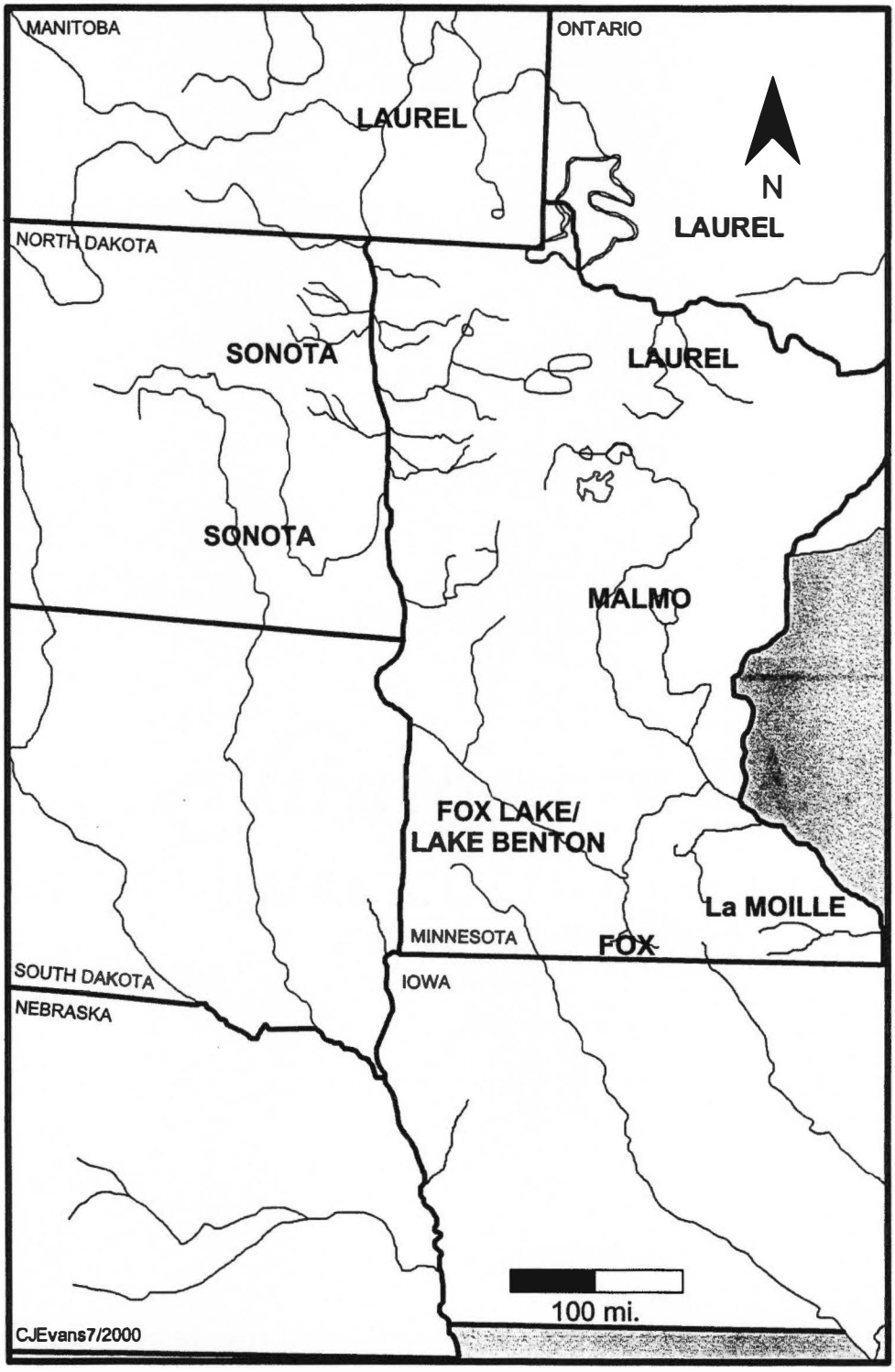


Figure 2-2. Distribution of Middle Prehistoric Period Archaeological Units.

Moille Thick, identified at the La Moille rockshelter (21WN01), Schilling (21WA01), Grey Cloud Island (21GD59), and the Anderson site (21AN01), represent the earliest evidence for pottery manufacture in Minnesota (Bonney 1970; Gibbon 1986; Hudak and Johnson 1975; Wilford 1955). There is some evidence of plant cultivation during the early margin of the Middle Prehistoric period. Dated at 3,750 B.P., the King Coulee site (21WB56) yielded fragments of *Cucurbit pepo* (Perkl 1998). The earliest evidence for maize cultivation occurs at the Nelson site (21BE24). This site has not been radiocarbon dated but ceramics similar to early Madison Ware were also recovered indicating an early date (Scullin n.d.).

It should be noted that the existence of an Early Woodland lifestyle in Minnesota has been questioned and ultimately rejected (Gibbon 1986). Gibbon (1986:89) concludes that "Minnesota lacks both Early Woodland complexes and a meaningful Early Woodland time period," although it is recognized that few sites in this time frame have been excavated. It is clear, however, that all of the classic Early Woodland culture traits, including increased sedentism, emergent intensive horticulture, burial mound construction and interment ceremonialism, and participation in widespread trade networks involving movement of exotic materials are absent in Minnesota until much later (Griffin 1964). The few ceramic vessels and sherds recovered from Minnesota sites that are most likely early Woodland candidates, including La Moille Thick, are found at sites where no major subsistence shifts are evident and that a generalized Archaic lifeway seems to have persisted throughout the temporal span of the Early Woodland. Gibbon (1986) feels that the larger questions center around how one should interpret an Early Woodland tradition in Minnesota:

"(1) as the incidental addition of ceramics and a few new litincs types to an essentially stable Archaic lifeway; (2) as a manifestation of an Archaic flourescence; (3) as a new technological stage marked by the ability to manufacture ceramics; or (4) as indicators of the emergence of a new Woodland lifeway based on marked shifts in settlement-subsistence practices and burial ceremonialism" (Gibbon 1986:89).

The Voight site (21WN15), located in extreme southeastern Minnesota, is one of only two mortuary sites that have been dated to what has been traditionally recognized as the time frame for an Early Woodland manifestation. The nature of artifacts recovered from the Voight site (crudely worked bone, stone, shell, and copper) during the 1961 excavation of the site, in addition to the absence of pottery, and the nonmound burial resulted in an initial designation as Archaic; however, a recent radiocarbon date of 2,557+/- 52 B.P. place the site unequivocably in the Early Woodland temporally period. The character of the site, however, lends credibility to the idea that Archaic lifeways continued until the advent of the Initial/Middle Woodland period in Minnesota (cf. Anfinson 1987; Gibbon 1986). Clearly the majority of the evidence indicates that there is not the shift in adaptive strategy seen in areas far to the south and east of the study region. For the purposes of this research,Voight (21WN15) is classified as Archaic due to characteristics of the site and a date close to the end of the Archaic Tradition. Morrison Mound (21OT02), the second site dated to this transitional period, will be evaluated as an Early Woodland site given the fact that it is a constructed mound. Its position relative to the earlier Archaic, Paleoindian, and later Middle Woodland groups.

Initial/Middle Woodland (2,200 - 1,100 B.P.).

The Middle Woodland is broadly characterized in the lower Midwest by the appearance of a variety of distinctive ceramic forms and styles, the emergence of more complex burials and mortuary-related rituals, increasing societal complexity as reflected by the presence of differential status, and participation in widespread trade networks that included the distribution of both materials (e.g. copper, obsidian, and pipestone) and ideology (e.g. social hierarchy, mortuary practices). A variety of Initial/ Middle Woodland phases have been defined for Minnesota. Middle Woodland peoples in Minnesota variously participated in what is known as the Hopewell Interaction Sphere (Streuver 1964, 1965). A single Middle Woodland context, Sonota, is represented in the biodistance analysis.

Fox Lake and Lake Benton. Anfinson (1997) states that the traditional Woodland temporal divisions of Early, Middle and Late do not seem reasonable for the southwestern prairie region of the state and instead proposes that the Woodland period for this region be represented by two phases, Fox Lake (2,200 - 1,300 B.P.) and Lake Benton (1,300 - 800 B.P.). Fox Lake represents a phase that in other regions of the Eastern Woodlands culture area date to the Middle Woodland. For this reason the Fox Lake phase is referred to as belonging to the Initial Woodland phase. There are several Initial Woodland ceramic styles (Anfinson 1997), however, Gibbon (1986:89) feels that the early ceramics, particularly Fox Lake Trailed "seem to be incidental additions to an Archaic lifeway that persisted throughout most of the Initial Woodland in southwest and south-central Minnesota."

A single mortuary site, Morrison Mounds (21OT02), may date to the Initial

Woodland period in the southwestern region of Minnesota. A radiocarbon date of approximately 690 B.C. was reported for Mound 13 of Morrison Mounds (21OT02) (Johnson 1964). The date was determined from a charred wood sample from one of the logs overlaying the central burial pit. The accuracy of this date has been questioned due to possible "atmospheric contamination" from open drawer storage and because only a single sample was dated (Anfinson 1997:15; Johnson 1964). It should be noted that radiocarbon dates determined from charred wood in similar situations from different sites have resulted in more acceptable, and more recent, dates (e.g. Malmo site, 21ML01, ca. 200 B.C.). If one accepts the early date, Morrison Mounds (21OT02) represents one of the few documented Initial Woodland sites and only one of two potentially Initial Woodland sites yielding human remains. Given the questionable date and burial in a constructed mound, human mortuary activity at Morrison Mounds has been classified as belonging to the Malmo phase, a Middle Woodland manifestation (Wilford 1942a). If the early date is ultimately accepted, the Malmo phase may have its origins much earlier than previously believed and the existence of an Early Woodland period should be reconsidered. For the purposes of the current study, Morrison Mounds will be classified as Initial Woodland to reflect its early date and distinct (from Voight, 21WN15) burial mode.

Havana and Lake Forest. Two Initial/Middle Woodland contexts in the central and northern region have been identified in Minnesota, Havana and Lake Forest, and represent the varied roles of Minnesota precontact cultures in the Hopewell domain (Dobbs 1988a). The Havana complex encompasses the cultural manifestations in the Upper Mississippi drainage that reflect some Hopewellian influence (Streuver 1964,

1965). The extent of this influence, however, is believed to be limited and significant local cultural developments (e.g., subsistence-related adaptations), distinct from Hopewellian cultures further to the south, exist. In Minnesota, the Howard Lake and Havana-related phases represent the northernmost extension of the Havana complex. Due to the fragmentary nature of the human remains associated with these phases, sufficiently complete crania were not available for measurement.

Fitting's (1970, 1978) Lake Forest Middle Woodland tradition is more widespread in this region and exhibits mortuary ceremonialism and ceramic manufacturing techniques and decorative styles that are distinct from Hopewellian influences. The Malmo and Laurel phases are representative of the Lake Forest Middle Woodland adaptation. Individuals representing both of these phases are included in the present study.

Malmo (2,200 - 1,800 B.P.). Malmo was first defined as an early focus of the Mille Lacs Aspect by McKern (1944). Subsequent excavations and research have resulted in a provisional designation as a ceramics phase in lieu of a distinct archaeological culture (Benchley et al. 1997). Malmo represents the earliest ceramic type in east-central Minnesota in the mixed coniferous and deciduous forest. Sites assigned to this phase cluster around the Mille Lacs Lake area. Fitting (1970) included Malmo as a member of the regionally-defined Lake Forest Middle Woodland group due to similarity in artifact composition and ecological base. Little is known, however, about the cultural system of the Malmo phase. Johnson (1988) describes the lifestyle as one characterized by small, highly mobile bands that subsisted on a variety of seasonally available food resources. They practiced mound burial, primarily in circular or conical earthworks, that represent a single construction phase. Malmo mortuary sites consisted of numerous mounds that

together represented a temporal series of construction over a number of years. Burials are characterized by their absence of grave goods and a secondary bundle mode of interment.

The nature of Malmo relationships to other populations is poorly defined and based solely on the analysis of artifactual remains. Ceramic styles indicate some interaction with the Hopewellian groups to the south in Illinois, southwest Wisconsin, and northeast Iowa (Johnson 1988). Wilford (1955) postulated an *in situ* development of the Late Woodland Kathio phase (A.D. 800-1400) from Malmo and speculated further that another Late Woodland manifestation, the more northerly Blackduck (A.D. 800 - 1400), also developed out of the Malmo phase. Ossenberg (1974), in her pioneering biodistance study of the Late Woodland period in the Upper Midwest, presented a different interpretation and felt that the similarities in artifact styles may reflect population convergence rather than evolution as a result of a greater degree of interaction. Increased reliance on wild rice would have enabled significant population growth resulting in more sedentary Late Woodland populations (e.g. Kathio and Blackduck) fostering more frequent population interaction, one consequence of which would have been technological and stylistic exchanges. The biological consequences of the more frequent and intensive contact is unknown at this time. The skeletal remains recovered from Malmo mounds are generally poorly preserved and fragmentary.

Laurel Phase (2,200 - 1,500/1,200 B.P.). Laurel is the sole phase context for the more northern Lake-Forest area. The Laurel phase was first defined by Wilford (1941) as a focus of the Rainy River Aspect of the Woodland Pattern. Further research refined the temporal range of this phase in Minnesota to the Initial/Middle Woodland period, 200

B.C. - A.D. 500/800 (Thomas and Mather 1996; Stoltman 1973; Wilford 1955). Analysis of the ceramics and seriation of the different types resulted in the definition of three to four phases: Pike Bay (200 B.C. - A.D. 300), McKinstry (A.D. 300 - 600); Smith (A.D. 600 - 900), and Hungry Hall (A.D. 900-1,200) (Lugenbeal 1976; Reid and Rajnovich 1991; Stoltman 1973).

Laurel is the most geographically extensive Initial/Middle Woodland phase in North America and extends east-west from northeastern Ontario to northeastern Saskatchewan and north-south from northern Minnesota to the Hudson Bay Lowlands; radiocarbon dates detail a 1,400 year span throughout this range (Gibbon 1994; Gregg 1994; Meyer and Hamilton 1994; Reid and Rajnovich 1991). A hunting and gathering adaptation characterizes the Laurel phase; annual migration patterns were determined by seasonal availability of plant and animal resources. There is little direct evidence of intensive reliance on any one plant food resource although it is hypothesized that exploitation of wild rice and maple sugaring were practiced. The Laurel phase is further defined by a distinctive assemblage of artifacts including the earliest ceramics in the mixed coniferous and deciduous forest-lakes region (Stoltman 1973). Analyses of material remains clearly indicate that Laurel shares similarities in adaptation and material culture to other components in the Lake Forest Middle Woodland region in the upper Great Lakes area. There is also some indication of interaction with the Hopewellian populations to the south; however, Laurel peoples maintained their autonomy and local distinctiveness (R. Mason 1981; Meyer and Hamilton 1994).

The identity of the ceramic "descendants" of Laurel have been greatly debated (see Meyer and Hamilton 1994). A number of scholars have hypothesized a Laurel-

Blackduck continuity (Buchner 1982; Dawson 1974; Evans 1961a, 1961b; Koezur and Wright 1976) while others (Hlady 1970; Syms 1977; Wilford 1945a) argue against it. Due to the practice of secondary burial, in addition to reburial in 1991 of all known Laurel remains in Minnesota, the Laurel culture is not represented in the current study. A single skull was measured by the author prior to reburial, but preliminary biodistance analysis identified it as an outlier and it was removed from the sample.

Sonota Burial Complex (2,000 - 1,400 B.P.). The Sonota Burial Complex has been most thoroughly described and summarized by Neuman (1975). Site types assigned to Sonota include low circular earthen burial mounds and small campsites. Sonota is frequently described in conjunction with Besant sites and the two are frequently linked as variations of the same complex due to similar stylistic expressions (Gregg 1994; Schlesier 1994). Sonota sites date between A.D. 1 and 600, although Snortland (1994) reports that an earlier date (290 B.C.) and a later date (A.D. 1300) are consistent with the temporal range suggested by projectile point types and may indicate the presence of multiple components at some Sonota sites.

A majority of Sonota mortuary sites are situated along a north-south segment of the Missouri River trench extending south from present-day Bismark, North Dakota (Schmidt site, 32MO20) to near the confluence of the Missouri and Moreau rivers (Arpan site, 39DW252) just south of Mobridge, South Dakota. A scattering of possible Sonota sites exist outside this area in eastern North Dakota (Baldhill Mounds) (Neuman 1975). Those sites in the Missouri River trench are placed on the lower terraces in a more riverine ecosystem, distinct in some ways from the surrounding plains environment. Indications are that the peoples who constructed and utilized these mounds were adapted

to a Plains-riverine environment, heavily dependent on gathering of local plant and animal resources and the hunting of bison; no evidence exists for maize horticulture. Gregg (1994:78) explains that not only were bison a primary focus of subsistence strategies at that time, but "a focal point in religious and spiritual practices as evidenced by the interment of bison remains along with human remains in Sonota mortuaries."

The Sonota complex presents a wide array of material culture ranging in artifacts constructed from both locally available materials, as well as more exotic, non-local materials. The presence of artifacts made from obsidian, copper, and exotic shells (*Anculosa* sp., *Busycon* sp., *Marginella* sp.), for example, indicated trade contacts with the Rockies (obsidian), the upper Great Lakes (copper), the Illinois and Ohio rivers (*Anculosa* sp.), the Gulf coast (*Busycon* sp.), and the Atlantic coast (*Marginella* sp.). Neuman (1975) interprets the burial mode (interment in centrally located, sub floor burial pits with exotic and locally-derived funerary goods) and ceramic design and treatment as indicative of Hopewell influence. Schlesier (1987, 1994), based largely on evaluation and interpretation of Cheyenne sacred tradition, suggests that the Besant-Sonota complex represents the prehistoric Cheyenne.

The Sonota Burial Complex is represented in the study sample by cranial remains from sites located along the Missouri River trench in North and South Dakota.

Late Prehistoric Period (1,100 - ca. 370 B.P.)

The Late Prehistoric period commences at circa 1,100 B.P. and continues until contact with Europeans circa 1630 A.D. Various trends, identified in the Initial/Middle Woodland period, continue and intensify in the Late Prehistoric period. "Seven major trends are apparent during the Late Prehistoric period. These include the intensification

of food production (maize horticulture in the south, wild rice in the north), introduction of new technology for tool use and manufacture, significant population increases and the emergence of well-defined regional complexes, the tentative association of archaeological complexes with known historic groups of American Indian people, interaction and influence with the highly developed Middle Mississippian cultures of the lower Midwest, and the interrelationship between human adaptations in the state and changing climate" (Benchley et al. 1997:169).

Figure 2-3 illustrates the known Late Prehistoric Period archaeological units for the study region.

Late Woodland (1,100 - ca. 370 B.P.)

The Late Woodland in the central and northern deciduous forest and lake-forest regions, as elsewhere in Minnesota during this period, was a time of significant change. In southern Minnesota and the rest of the Midwest this process revolved around maize horticulture. In northern and central Minnesota, the increased reliance on wild rice (*Zinzania aquatica*) purportedly served as the impetus for this change (Gibbon and Caine 1980; Johnson 1969; Lofstrom 1987). The use of wild rice as a significant food resource may occur as early as the Middle - Late Woodland transition period (Gibbon and Caine 1980) but definitely by 800 A.D. (Johnson 1969). Lofstrom (1987) postulates that intensity of use increased from St. Croix times through the Blackduck phase and reached its greatest degree of exploitation by the end of the Late Woodland period (during the Sandy Lake phase). The process of intensification and its consequences is best understood for the central Minnesota Mille Lacs region where Johnson (1969, 1971, 1985) and Whelan (1990) have documented the presence of wild rice and related

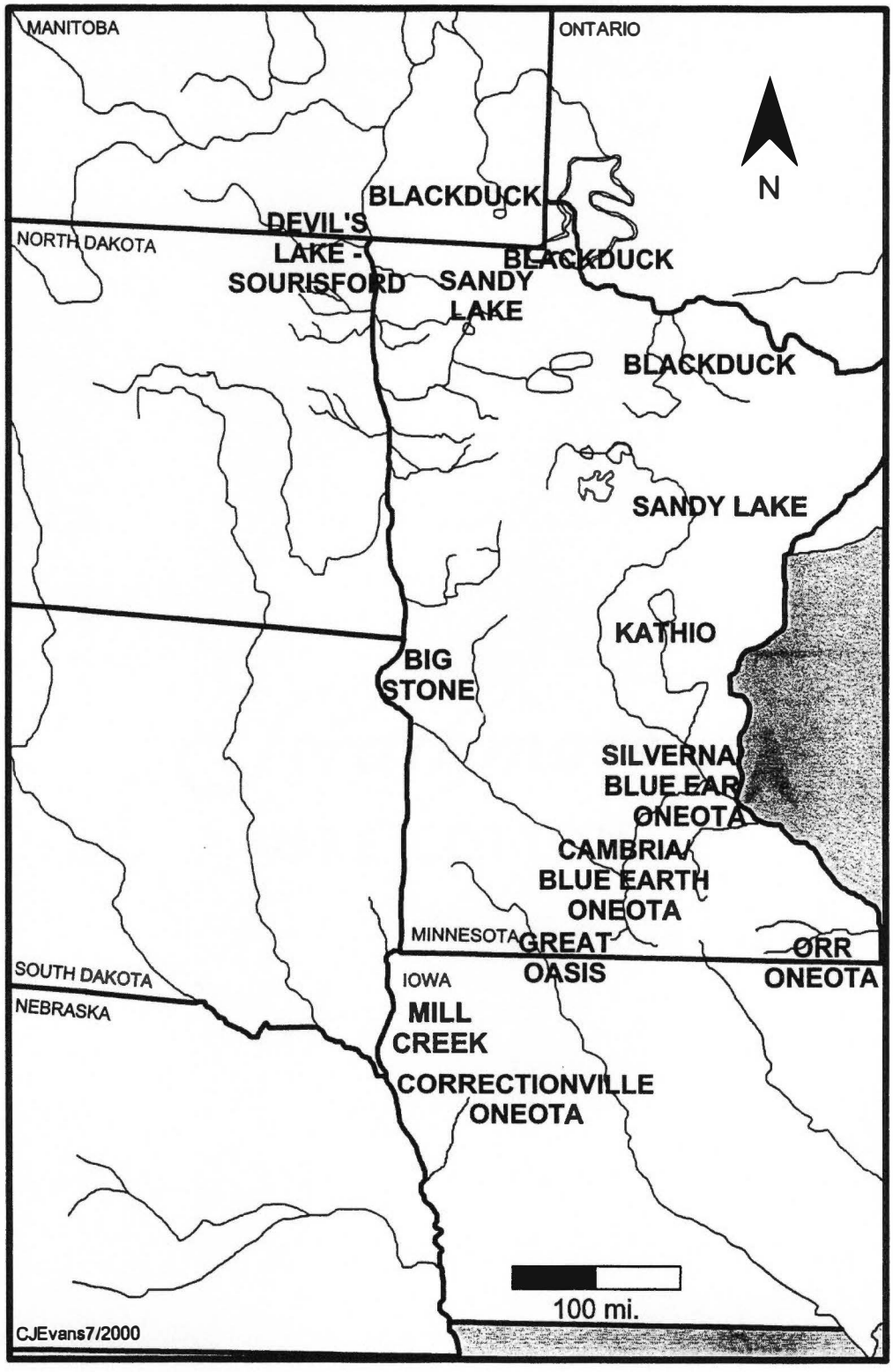


Figure 2-3. Distribution of Late Prehistoric Archaeological Units.

processing and storage features, a significant increase in number and size of sites, and year round occupation of village sites. Co-occurring with this new intensive reliance on wild rice was a rapid increase in population size, a decline in mound construction, and decreased reliance on widespread networks of neighboring groups and kin relationships (Lofstrom 1987).

This region has great potential to answer questions regarding population relationships between Late Woodland groups in the different regions as well as to historic Native American groups (Gibbon 1994; Johnson 1985; Michlovic 1990), and the biological manifestations of physical and social adaptations to increased sedentism, increased social complexity, and intensive reliance on a limited number of food resources (although supplemented by hunting and gathering of locally available resources) (Myster and O'Connell 1997).

Kathio Phase (1,100 - 700 B.P.). The Kathio phase is primarily an east-central Minnesota manifestation and is most highly concentrated in the Mille Lacs Lake region within the deciduous forest environmental zone. A smaller number of Kathio sites, however, are found in the northern lake-forest region and the Prairie Lakes region to the south. Kathio was initially defined by Wilford (1941, 1955) as a focus in the Mille Lacs Aspect of the Lake Michigan Phase of the Woodland Pattern and finally, of the Late Woodland Period. Kathio is believed to represent a later manifestation of a continuum commencing with the Middle Woodland Malmo phase. Similarities in ceramic manufacture indicate relationships to the Blackduck and Lake Benton ceramic series in Minnesota, and Clam River in Wisconsin (Benchley et al. 1997; Gibbon 1994). Wilford (1955) and later, Johnson (1985), associate Kathio with the Eastern Dakota, specifically

the Mdewakanton.

No significant differences in the burial protocol distinguish the earlier Malmo from Kathio. Both phases are characterized by secondary bundle burial in shallow pits, semi-articulation of some body elements, the overall absence of associated burial goods, logs over and or under the skeletal remains in various stages of charring, and small stone cairns placed on the mound floor (Wilford 1955). The generalized Woodland culture traits and similarities in material culture as well as burial practices between Malmo and Kathio result in some degree of uncertainty regarding site assignment. "Because of its rather generalized Woodland traits, and its wide range of pottery decorations and burial practices, Mille Lacs Aspect as defined here may be somewhat of a Woodland "catchall" (Wilford 1955:136). This certainly seems to be the case as Wilford has attributed mortuary sites distributed over a wide geographic range to the Kathio focus based solely on the presence of secondary bundle burials and the lack of associated burial artifacts. Few "Kathio" mortuary sites have been radiocarbon dated and, therefore, the reliability of many of Wilford's designations, especially of sites outside of east-central Minnesota, is questionable. No definitive Kathio sites yielded crania complete enough for inclusion in the current study.

Blackduck Phase (1,200 - 600 B.P.). Like many archaeological manifestations in Minnesota, Blackduck was first defined by Lloyd Wilford (1941, 1955). Based upon his work at both the Shocker habitation site (21BL01) and Osufsen Mound (21IC02) (Wilford 1937b, 1943b), Wilford placed the Blackduck Focus within the Rainy River Aspect of the Lake Michigan Phase of the Woodland Pattern of the Late Woodland Period. Subsequent researchers have conducted numerous excavations that have enabled

archaeologists to refine and modify the definition of Blackduck (Arthurs 1986; Lugenbeal 1978; MacNeish 1958; Nicholson 1996; Thomas and Mather 1996).

The geographic distribution of Blackduck extends from northwestern Michigan and the Upper Peninsula west to east-central Saskatchewan (Meyer and Hamilton 1994). "In Minnesota, Blackduck is widely distributed across the state, with a particularly heavy concentration of sites in the Rainy River region, and numerous sites throughout the Mississippi Headwaters area" (Dobbs 1988a:225). Temporally the Blackduck phase extends variously from A.D. 800 - 1400, with a shorter time span in the Headwaters area and a longer span in the more northern Rainy River region. In the more northern reaches of its geographic distribution Blackduck persists until contact with European explorers as evidenced by an association of Blackduck pottery and European trade artifacts north and northwest of Lake Superior in Ontario and Manitoba. In Minnesota, the Blackduck phase concludes prior to European contact and co-occurrence of prehistoric and historic artifacts is absent. Blackduck burials occur both in mounds and habitation sites. Blackduck is one of the best represented phases in the current study, comprised of sites located both in Minnesota, Ontario and Manitoba.

Sandy Lake (Wanikan/Psinomani Culture) Phase (1,000 - 300 B.P.). The Sandy Lake phase is a widely distributed Upper Mississippian Late Woodland manifestation. The initial designation proposed by Cooper and Johnson (1964) was based on materials, primarily ceramic, recovered from sites in northern Minnesota and northwestern Wisconsin. The geographic range of Sandy Lake is poorly known, but associated ceramics are found from central Minnesota to Ontario and from northwestern Wisconsin westward through the Red River Valley into eastern North Dakota (Birk 1977; Gibbon

1994; Michlovic 1982, 1986, 1987). Within Minnesota, then, Sandy Lake ware is found in three biomes, the deciduous-coniferous lake-forest region, the deciduous forest region, and the prairie region of the Red River Valley. The temporal distribution of Sandy Lake is equally hazy, but appears to replace Blackduck in the lake-forest Headwaters area between A.D. 1100 - 1200 and, in the deciduous forest, replaces Kathio at about the same time. Interestingly, Sandy Lake is contemporaneous, at least for a time, with Blackduck in the extreme northern portion of Minnesota and Ontario, as well as contemporary with Plains Village groups in the prairie region of the Red River Valley (Benchley et al. 1997).

Birk (1977) suggests that Sandy Lake ware is a material component of a larger cultural manifestation which he defines as the Wanikan Culture. "... I propose the formulation of the Wanikan Culture to denote the collective phenomena observed as Sandy Lake potteries and their associated cultural expressions ... Characteristics of the Wanikan Culture ... include but are not confined to: Sandy Lake ceramic wares; intrusive mound burials; exclusive circular conical mounds with shallow burial pits; primary flexed interments with associated mortuary vessels; small triangular projectile points (predominantly quartz?); formally prepared ricing jigs or threshing pits; fire hearths and pits; middens; small, seasonally occupied sites in recognizable lakes area patterns; and the inferred use of wild rice as a staple crop" (Birk 1977:30-31). Johnson (1985) expands on this by postulating a "forest-prairie edge area adaptation which included bison hunting, wild rice harvesting, fishing, the hunting of woodland mammals, and gathering and collecting activities in both biomes".

There are few known Sandy Lake mortuary sites and the cranial remains from one

were to incomplete for inclusion here. Another Sandy Lake individual was made available too late to be included in the current study. For these reasons, Sandy Lake is not represented in the study sample.

As observed in northern and central Minnesota, the archaeological record of the Late Prehistoric period in the southern regions of the state bear witness to significant and far-reaching cultural changes. Beginning at approximately 1,000 B.P. observable changes include the presence of ceramic traditions significantly different in form and style from Woodland types, a new settlement-subsistence pattern based on the exploitation of riverine resources and maize horticulture, the appearance of human populations, namely Middle Mississippian, Plains Village, and Oneota complexes, practicing a lifestyle vastly different from the local Late Woodland populations, and technological changes including shell-tempering in ceramic production, widespread use of the bow and arrow, and storage pits for long-term storage of harvested crops (Anfinson 1997; Benchley et al. 1997; Gibbon 1994).

Significant for the current study is the understanding that the Middle Mississippian, Plains Village, and Oneota peoples did not immediately replace the local Woodland groups, but instead adopted some cultural practices well-adapted to the Prairie, Prairie-Lake, Deciduous Forest regions. The southern region of the state, then was populated by a number of distinct groups utilizing locally available resources and interacting with one another. Anfinson (1997) believes this situation exemplifies E. Leigh Sym's (1977) Co-Influence Sphere model.

Much research has focused on the emergence of the various groups (e.g., Oneota, Silvernale, Mill Creek, Cambria) and the possible "ancestral role, if any, of Cahokia-

based Mississippian cultures (through population intrusions and/or influence)" (Gibbon 1994:136). Numerous transformation models have been proposed (Alex 1981; Anfinson 1987; Benn 1989; Gibbon 1974,1982; Henning 1970; Tiffany 1991), most promoting that "transformation was from a Late Woodland base, with contact with more complex Mississippian polities, climatic change, indigenous cultural developments, and other factors assuming varying degrees of importance in one model or another" (Gibbon 1994:136). The nature and degree of local interaction with Mississippian cultures has profound implications for biodistance analyses.

Oneota Aspect (ca.1,000 - 350 B.P.)

The Oneota are encountered in the archeological record in Minnesota as early as A.D. 1,000 in the Red Wing locality centered around the confluence of the Cannon and Mississippi rivers. Oneota was originally defined by Orr (1914) for northwestern Iowa. Wilford (1941, 1955) later defined the Oneota as an aspect in the Upper Mississippi Pattern of the Late Woodland Period. He delineated four foci within the Oneota Aspect: Orr, Blue Earth, Silvernale and Cambria. More recent research has resulted in a reorganization of Wilford's taxonomic categories and the removal of Oneota from the Middle Mississippi tradition. Silvernale is currently considered a Middle Mississippi manifestation, Cambria has been transferred to the Plains Village Tradition, and the Orr and Blue Earth foci remain within the Oneota Aspect/Tradition. Subsequently, the Red Wing locality was added as another area of Oneota population concentration (Dobbs 1984).

Oneota tradition currently refers to "a series of related archaeological cultures that is distributed widely throughout the Prairie Peninsula, adjacent woodlands (Wisconsin,

northwestern Indiana, and Illinois), and eastern portion of the Plains (western Iowa, South Dakota, Nebraska, Missouri)" (Dobbs1988a:198). Culture traits that broadly characterize the Oneota include shell-tempered globular ceramic vessels with distinctive decorative motifs, a reliance on maize horticulture, and a complimentary reliance on both bison and aquatic faunal and floral resources. Three regions within the state experienced dense Oneota occupations that have been systematically studied, the Red Wing Locality, the Blue Earth River Valley of southern Minnesota, and the Root River region also in the southeastern area of the state. Additionally, Oneota ceramic sherds and a few other examples of Oneota material culture are more widely distributed and occur in the central, northern and northwestern regions (Dobbs 1988a; Gibbon 1995). Human remains are unequivocally associated with each of the three main regions of occupation, and possibly with the more peripheral locations as well, although whether the presence of Oneota artifacts outside of their traditional range indicates population migration or trade and/or diffusion of technological knowledge is unknown (see Gibbon 1995).

Red Wing Locality. The earliest appearance of the Oneota in Minnesota occurs in what has been termed the Red Wing Locality. Temporal placement of the Oneota within this area is between A.D. 1000 and 1300. Two distinct groups are identifiable in this area during this time frame, the Middle Mississippian Silvernale focus and the Oneota. The Red Wing Locality, in fact, is one of the "focal points for Mississippian interaction" and "is the most northern center of Mississippian interaction in eastern North America and is (arguably) the largest cluster of Mississippian-related sites in the northern Mississippi Valley (Benchley et al. 1997:170). The Bryan site (21GD04) is the only site in the Red Wing Locality that may contain an Oneota mortuary component. Bryan is a habitation

site that is situated on a terrace along the south side of the Cannon River. Human remains were recovered from a variety of contexts within the Bryan site including both non-mortuary and mortuary contexts. The affiliation of the human remains recovered from the Bryan site is largely unknown. A number of individuals have been reported as "storage pit burials" and these are clearly affiliated with the Silvernale Focus (Glenn 1974). Two individuals from the Bryan site are included in the present study as representative of the Mississippian Silvernale phase; no individuals from the Red Wing locality are included as representing the Oneota Tradition.

Orr Phase (Root River Locality) (600 - 350 B.P.). The Orr Phase was first defined by Keyes (1934) and refined and expanded by several other researchers (Henning 1970; Wedel 1959). Orr includes sites located in both Iowa and Minnesota. Minnesota Orr Focus sites are concentrated along the Root River in southeastern Minnesota and are believed to date between A.D. 1400 - 1650 (European contact), though a lack of radiocarbon dates for the early Orr sites make the emergence of this phase elusive. The historic Iowa tribal group are well demonstrated to be the historic representatives of the Orr phase (Mott 1938; Wedel 1959, 1976). The Orr phase is represented in the current study by three Minnesota sites and one Iowa site.

Blue Earth River (ca. 900 - 600/500 B.P.). The Blue Earth Oneota sites are concentrated in the Blue Earth River valley of the Prairie Lake region centered in the southern portion of Minnesota. The Oneota in this region are first documented ca. A.D. 1050/1100 and subsequently became the dominant group in southern Minnesota between approximately A.D. 1200 - 1400. Termination of this manifestation is unknown, but may have continued until A.D. 1450/1500 (Anfinson 1997). The Blue Earth Oneota are

somewhat distinct from the other Oneota complexes in the state in subsistence practice and settlement patterns due to location within the Prairie Lakes biome. Subsistence centered around a maize horticulture coupled with bison hunting. The settlement pattern differs from the earlier Woodland populations from this region who settled "along the margins of the prairie lakes and in stream valleys. These sites are widely distributed across the landscape. Oneota sites, however, are found on the west side of the Blue Earth River and are tightly clustered in two localities. These have been termed the Center Creek and Willow Creek Locality...." (Dobbs 1988a:209).

The Center Creek Locality of the Blue Earth Oneota are represented in the present study by two sites in Iowa and one in Minnesota.

Plains Village Tradition (1,100 - 325 B.P.)

Plains Village is an archaeological manifestation that flourished on the Great Plains and adjacent prairies to the east in Minnesota and Iowa between A.D. 900 - 1675. This late prehistoric context incorporates three traditions: the Central Plains, Middle Missouri, and Coalescent. Plains Village manifestations in Minnesota represent the eastern extent of this context and all fall within the Initial variant of the Middle Missouri Tradition (Gibbon 1993; Lehmer 1971). Six phases have been defined for the eastern range of the Initial variant (Henning 1989); only two of these phases, Great Oasis and Cambria, are present in Minnesota. Also relevant to the current study is the Mill Creek phase, centered in northwest Iowa. All Middle Missouri Tradition sites in Minnesota are within the Prairie and Prairie Lakes ecological zones. Additional Middle Missouri sites included in the study for comparative purposes come from the prairie regions of Iowa, South Dakota, and Nebraska.

Great Oasis Phase (1,100 - 800 B.P.). The inclusion of the Great Oasis phase as part of the Initial variant of the Middle Missouri Tradition is undecided. Anfinson (1997:90) states, "There is some disagreement as to whether or not Great Oasis should be considered part of the Middle Missouri Tradition. It does have stronger Woodland influences than other Initial Variant phases and lacks certain Middle Missouri traits such as fortified villages. There seems to be general agreement, however, that Great Oasis is ancestral to Initial Middle Missouri." Key (1983) included Great Oasis in the Plains Woodland Tradition on the basis of questionable reliance on agriculture and its relationship to other Plains Village manifestations such as Mill Creek and Over phases (Ludwickson et al. 1981: 133-140).

Great Oasis represents one of the earliest of the Plains Village phases. It is very widespread with populations distributed in northwestern Iowa, eastern and central South Dakota, northern Iowa, southwestern Minnesota, northeastern Nebraska, and western Illinois (Henning 1971). Great Oasis sites included in the present analysis are from South Dakota and Nebraska; no Great Oasis sites yielding human remains have been excavated in Minnesota.

Mill Creek Phase (1,100 - 700 B.P.). Mill Creek is an early phase of the Initial variant, with a temporal range between A.D. 900 - 1,300. Geographically Mill Creek sites are located in northwest Iowa and are distributed in two tight clusters, one on the Big Sioux River, the other on the Little Sioux River; Tiffany (1983:93) advocates assigning each cluster to distinct similarly named phases.

Mill Creek exhibits a suite of characteristics distinctive to the Middle Missouri Tradition. These include villages consisting of 20 - 30 houses; simple fortification of

some villages; reliance on bison; other large game animals; and maize horticulture; long, rectangular semi-subterranean houses arranged in rows; and globular-shaped ceramic vessels with cord-roughened and plain exterior surfaces. Of particular interest, however, is the significant degree of Mississippian influence reflected in the material culture recovered from Mill Creek sites. The presence of Mississippian artifacts had previously been interpreted to indicate a Mississippian origin for Mill Creek via a Mississippian migration from Cahokia, through Aztalan (47JE01) (Wisconsin) and the Minnesota Cambria (21BE01) site. The majority of all ceramics in Mill Creek sites are typical of Initial variant types, however, and it is now widely held that Mill Creek was an *in situ* development and "the Mississippian traits in Mill Creek sites reflect increasing contact and interaction between Initial variant and Mississippian groups rather than migration around A.D. 1000; this increased activity was the result of the expanding influence of the Mississippian culture area centered at Cahokia" (Tiffany 1983:93).

The origins and demise of the Mill Creek phase may indicate possible genetic relationships between it and other phases in the study sample. Currently the most likely ancestor for Mill Creek are some of the groups that comprise the more widely distributed, and, in part contemporaneous Great Oasis phase distributed from eastern South Dakota, southwest Minnesota, and northwest Iowa (Gibbon 1993; Henning 1969; Tiffany 1983). Several hypotheses have been formulated to explain the demise of Mill Creek most of which involve migration west and north along the Missouri and intermixing/blending with other groups (Anderson 1987). McKusick (1964), for example, postulates that Mill Creek peoples abandoned their villages during the 1500s and migrated west toward the Missouri River. Henning (1969) believes Mill Creek peoples worked their way gradually

up the Missouri, intermingled with other groups ultimately becoming part of the late Over focus. Finally, Anfinson (1987:526) "argued that the Mill Creek people underwent rapid acculturation as they moved north and west (perhaps under pressure from the Oneota) and merged with the developing tribes of the Historic period".

Two sites from Iowa, representing the Mill Creek phase, are included in the study sample.

Cambria Phase (1,100 - 700 B.P.). Cambria was initially defined by Wilford (1945b, 1955) and placed within the Mississippian pattern. Subsequent research resulted in reclassification of Cambria as a phase within the Initial variant of the Middle Missouri Tradition (Anfinson 1997). Cambria phase sites in Minnesota have been divided into four categories including large village sites, secondary villages in close proximity to the larger villages, smaller prairie-lake and riverine sites, and mortuary sites (Johnson 1991). All sites are concentrated in the Prairie and Prairie Lake regions of southwestern Minnesota. The temporal distribution of Cambria is unclear but appears to exist between A.D. 900 - 1300. Johnson (1991) concludes from a careful consideration of existing information on all Cambria sites, that the Cambria phase emerged from an earlier, local Woodland population.

Subsistence practices varied according to category of site but was "dominated by bison hunting but with a supplementary range of utilization of smaller mammals, fish, and waterfowl" (Johnson 1991:307). Two competing models have been proposed to explain Cambria settlement and subsistence practices. Johnson (1986:10-11) suggests "that populations in this larger region were interacting in a system of exchange dominated by populations at the Cambria site and that their system was tied to a larger

Cahokia-based trade network ... the Cambria Phase was one sub-set of that extractive network, Mill Creek [in Iowa] another, and Silvernale the third in this northern Cahokia-based system." Watrall (1974) has hypothesized quite a different model based on the deterioration of the subsistence environment which necessitated the westward migration of Cambria and other peoples in the region at this time. Further data are needed to evaluate the validity of the two models.

A single site in Minnesota represents the Cambria phase in the present study.

Big Stone Phase (900 - 700 B.P.). The Big Stone phase, initially proposed by Haug (1983) for the Hartford Beach site (39RO05), was refined, expanded and formally defined by Anfinson (1997:104-112) to include sites located in the vicinity around Traverse and Big Stone lakes in Minnesota. Big Stone sites differ in several important aspects from the Cambria phase. Distinguishing characteristics of this phase include small fortified villages, ceramics that exhibit more similarities to Woodland types, a subsistence mode that emphasized bison hunting, fishing, and maize horticulture, and burial in earthen mounds in a flexed primary position with few grave accouterments. Overall, the Big Stone Phase, "appears to be a more satisfactory classification than Cambria to deal with the Plains Village sites of the northwestern Prairie Lake Region" (Anfinson 1997:104). Three sites in Minnesota are included in the present analysis as representative of the Big Stone phase.

Middle Mississippi (1,000 - 600 B.P.)

Several distinct cultural groups were occupying overlapping areas of Minnesota in the southern half of the state by approximately A.D. 1000. Peoples of the Cambria and Great Oasis phases of the Initial Middle Missouri Tradition were present in the southern

Prairie and Prairie Lakes areas, Oneota groups inhabited portions of central and southern portions of the deciduous forest region, as well as the Prairie Lake ecological zones, Late Woodland peoples were also present in the deciduous forests of the Eastern Woodlands zone in the southeastern portion of the state, and a small Middle Mississippi presence, represented by the Silvernale phase, is documented in this region as well. All of these groups practiced a more sedentary existence that included a dependence on maize horticulture complemented by the hunting and gathering of locally available flora and fauna.

The Middle Mississippi influence in the regions peripheral to the Mississippian center of Cahokia has been discussed at great length (c.f. Emerson and Lewis 1991; B. Smith 1978; Stoltman 1991). Cahokia represents the zenith of Mississippian development as evidenced by its far-reaching influence, great size, and complex socio-political organization earlier considered the center of a state level society (Conrad and Harn 1972; O'Brien 1972), and more recently, a high level chiefdom (Emerson and Lewis 1991; Stoltman 1991). It is unanimously acknowledge that "its far flung influences and interactions throughout the Southeast and upper Midwest represent the most dominant theme in the late Prehistoric time period of eastern North America" (Benchley et al. 1997:136). Middle Mississippian groups generally exhibited a sociopolitical structure with centralized leadership and an "emphasis upon community-oriented social and religious activities ... Middle Mississippi communities were centered on a temple town with one or more earthen temple mounds and open plazas as central features" (Hall 1986:368). The contemporary Cambria, Great Oasis, Big Stone, Oneota, and Late Woodland groups were less formally organized socially and their habitation

areas were organized in distinctly different ways. The nature of the relationship, presence, and influence of the Middle Mississippi peoples to the contemporary late prehistoric populations in Minnesota and neighboring regions remains unclear although several researchers have hypothesized various scenarios (Emerson and Lewis 1991; Gibbon 1974, 1979, 1991; Hall 1986; Johnson 1961, 1986, 1991).

Gibbon (1991) summarizes the impact of the Middle Mississippian "cultural sphere" in Minnesota and presents evidence for its influence at several sites. He concludes that the greatest influence occurred between A.D. 1050 and 1300 in the Red Wing locality but sees "no evidence of a site-unit intrusion of any kind. Instead only selected Middle Mississippi traits occur in what I interpret as culture contact situations involving a largely local population base. Such traits are most abundant in Silvernale phase sites in the Red Wing area at the juncture of the Mississippi and Cannon rivers. ... The general assemblage of Silvernale phase sites is dominated, however, by Oneota and what may be Oneota-Middle Mississippi "blended" artifacts and structures. Middle Mississippian-related traits also appear in a few Cambria phase sites along the Minnesota River in a still more diluted form" (Gibbon 1991:220). Gibbon (1991:220) explains the presence of these traits and the syncretistic nature of the Mississippi Silvernale phase by the participation of the Oneota and Cambria peoples in a "Cahokia-centered extractive-exchange network in southern Minnesota between A.D. 1050 and 1100." There are no Middle Mississippi mortuary sites listed in the Minnesota bioarchaeology database. It is believed, however, that several individuals from the Bryan site (21GD04) may be attributed to the dominant Mississippian Silvernale phase documented at the site. Human remains have been recovered during the numerous excavations that have been conducted

over the past 130 years (Dobbs 1984; Muller 1995; Wilford 1984) and can be assigned to two categories, isolated skeletal elements in non-mortuary features and intentional interments. The affiliation of these remains, however, to either the Oneota or Silvernale occupation is unknown. If a Silvernale phase is represented in the current sample it will be the two individuals from the Bryan site (21GD04).

Late Prehistoric Burial Complexes

There are two Late Prehistoric burial complexes that fall within the study region, Devils Lake - Sourisford and Arvilla. Symes (1982) considers the significant contributions that the study of burial complexes can bring to the understanding of past cultural systems. Coupled with the benefits of such research are a number of limitations necessary to keep in mind when incorporating burial complexes into a study comprised primarily of archaeological "cultures". First, it is well to remember that a burial complex represents, at least primarily, "one subsystem of an integrated set of subsystems making up a single dynamic, integrated system of values and beliefs" (Clarke 1968:101-103). A burial complex is "primarily part of the religious subsystem although it obviously includes part of the economic subsystem and may reflect part of the social subsystem" (Syms 1982:136). A second caveat is that the material remains recovered from each burial site vary making it difficult to identify related sites and understand the range of artifactual variability. This limitation is multiplied when, as is common in the Northeastern Plains, the mounds are small and total number of artifacts recovered is low. Nevertheless, the potential of burial complexes to yield significant insight into the past cannot be overstated. They contribute unique information relevant to, for example, the reconstruction of religious and ritual systems, cultural and economic trade interactions,

settlement and subsistence practices, marriage and post-marital residence practices, and the presence/absence of social status differentiation. From a biocultural perspective, the human remains contribute unlimited information on genetic interaction with neighboring populations, demographic profiles, health and nutritional well-being, the biological consequences of various cultural practices (diet, physical activity, child-rearing), and ancestor-descendant relationships.

Arvilla (1,500/1,400 - 600 B.P.). The Arvilla Burial Complex is easily the most enigmatic of the burial complexes included in the current study; little can be said about it with any unanimity. Disagreement between scholars characterizes each category of information including temporal range, spatial distribution of sites, defining artifacts and traits inventory, and descendant historic tribal affiliation (W. Anderson 1962; Johnson 1973; Michlovic 1983; Michlovic et al. 1977; Obey 1974; Ossenberg 1974; Syms 1982; Wilford 1941, 1955).

Arvilla was first classified as a distinctive archaeological manifestation by Wilford (1941). The Arvilla Focus, along with the Lake Traverse Focus, comprised the Red River Aspect of the Lake Michigan Phase in the Woodland Pattern. At this point, all sites were distributed along the east-west tributaries on either side of the Red River of the North, between Lake Traverse and Minnesota-Manitoba international border. The Red River bisects a portion of the basin of Glacial Lake Agassiz and the Arvilla sites were most commonly located on the ancient beaches of the lake where they were intersected by the tributaries. In Wilford's 1955 revision of his 1941 taxonomy, he does little beyond placing the Arvilla Focus in the Late Woodland Period and removing the Lake Traverse Focus. In 1973, Arvilla was subject to a more in-depth evaluation when Elden

Johnson, undertook to organize and publish Wilford's excavation field notes on several Arvilla sites, report on information from several recently excavated Arvilla sites, and define the temporal range, geographic distribution, and definitive material culture of what was then termed the "Arvilla Complex." Johnson's primary contribution was to provide a chronological framework based on radiocarbon dates and extend the known geographic distribution of Arvilla to include several sites in an east-west swath from the mouth of the Red River to the St. Croix River and three sites in the vicinity of the Pembina River where it crosses into Manitoba from North Dakota. In addition, Johnson (1973) described the artifact inventory and burial program from each site and summarized the osteological information presented in Wilda Anderson's (1962) unpublished Master's thesis. He concluded that the artifacts "associated with the burials are both utilitarian and ornamental grave goods. ... The Arvilla Complex contains an artifact assemblage that is northern, and the intrusion of marine shell trade goods of southern origins should not obscure this fact" (Johnson 1973:66).

Syms (1982) provides the most recent re-analysis of Arvilla as a burial complex. This work is unequivocally the most in-depth, holistic review of what is know to date, and undertakes to critically examine the current state of knowledge about Arvilla from an archaeological, biological and linguistic perspective. After explicitly stating some of the limitations and unique contributions to reconstructing past cultural systems from burial complexes, Syms sheds considerable light on the diagnostic elements, or lack of them, of Arvilla, the temporal and geographic distribution of sites, the biological "profile" of the associated human remains, and phenetic relationships between Arvilla, surrounding late prehistoric groups, and potential descendant historic tribal groups. Analyses of the

human remains by W. Anderson (1962), Obey (1973), and Ossenberg (1974) indicate a high degree of heterogeneity and closest affiliation to Algonquian groups; these results will be discussed in greater detail in Chapter 5.

The temporal range for Arvilla was initially delimited from four radiocarbon dates Johnson (1973). A consideration of these dates led to a range of between 500/600 - 900 A.D. Syms (1982) extended the date to approximately 1,400 A.D. on the basis of the presence of St. Croix pottery and a Blackduck ceramic vessel in association with Arvilla burials. The Manitoba "Arvilla" sites, as well as the archaeological site of Fidler, were excluded from Arvilla and re-classified as Devils Lake - Sourisford (see below).

The artifact inventory is frustratingly diverse and must be considered with care since all Arvilla sites are mortuary sites, reflecting a type of special-purpose sites. Syms (1982), determined there were 57 types of artifacts of both local and nonlocal origin and that 31 (54%) of these occur in only one Arvilla site. Most diagnostic of Arvilla are the clay elbow pipes and clam shell gorgets which appear to be unique to the Arvilla Burial Complex. Several differences were noted that serve to distinguish Arvilla from the Devils Lake - Sourisford Burial Complex, and Sonota. Overall, however, Syms (1982:162) was frustrated in his attempt to define a diagnostic trait list for Arvilla and concludes "Conclusions about Arvilla are premature at this time. It is questionable whether the sites lumped under Arvilla to date are part of a single complex, hence a single biological population or ethnic group."

The Arvilla Burial Complex is represented in the present study by cranial samples from sites in Minnesota and North Dakota.

Devils Lake - Sourisford (1,100/1,000 - 600 B.P.). The Devils Lake - Sourisford

Burial Complex, as defined and summarized by Syms (1979), encompasses Howard's (1953) "Southern cult-bearing culture of the Northern Plains." It extends between the Aspen Parkland and Missouri Coteau in North Dakota and Manitoba with distinctive site concentrations around Devils Lake in central North Dakota and the Souris Locality in southwestern Manitoba. The site inventory is comprised of mound sites and one possible habitation locale (Syms 1979). Although there are a few sites situated in the mixed prairie/forest Aspen Parkland, the complex is defined primarily in a prairie setting. Based on only a limited number of radiocarbon dates and the interpretation of diagnostic artifacts, Devils Lake -Sourisford represents a Late Prehistoric manifestation, ranging in time from A.D. 900/1000 - 1400 (Syms 1979).

The nature of the recovered artifacts indicates interaction with, or influence by, a number of contemporaneous groups including phases within the Middle Missouri Tradition, Mississippian groups, and the participants in the neighboring Arvilla Burial Complex. With the wide array of populations in the area during the time span of this complex and early ethnographic reports of large intertribal rendevouz', it is not difficult to picture significant, long-term interaction between groups. In fact, similarities in artifact inventory exist between Devils Lake - Sourisford and each of the groups mentioned indicating, minimally, involvement in similar trade relationships and cultural interaction. Location in or proximity to the vast prairies implies that participants in the Devils Lake - Sourisford Burial Complex practiced a settlement - subsistence system based on seasonal bison hunting. Syms (1979) offers provocative evidence that indicates the distribution of Devils Lake - Sourisford sites is related to the seasonal movement of bison.

Syms (1979) explores potential candidates for Devils Lake - Sourisford descendants. He notes as possibilities the Mandan, Crow, Hidatsa, Assiniboine, Teton, or some of the Santee (Eastern) Dakota groups. Considering the location of each group at the earliest documented contact with European explorers and the evidence for extensive Mississippian influence, Syms (1979) concludes that the most likely descendant groups are Siouan, possibly the Assiniboine, Teton, or Crow.

Crania from both North Dakota and Manitoba Devils Lake- Sourisford sites are included in the present study.

The Historic Period (ca. 1630 A.D. - present)

The contact period, defined by Hinshelwood (1984:84) "as a period of direct and sustained contact between Europeans and native groups represented by the establishment of trading centers or posts and duly recorded in extant primary historical documents.", varies across the study area, however, evidence from primary documents including journals, maps, and letters indicate this period commenced circa 1630 A.D. in Minnesota. Dobbs (1988b) divides this period into 11 contexts presented as eight ethnographic American Indian tribal groups, the French, the British, and the Americans. The eight tribes are those believed to be present in Minnesota during the earliest period of European contact and include the Iowa, Oto, Winnebago (Ho-Chunk), Eastern Dakota (or Santee, comprised of the Mdewakanton, the Wahpeton, Wahpekute, and Sisseton), Teton, Yankton, Chippewa (Ojibwa), and Assiniboine. Other tribal groups known to, or believed to, have inhabited the remainder of the area under study here include the Cheyenne, Cree, and Hidatsa (see Winchell 1911). The tribal groups listed above belong to two major language families, the Algonquian and Siouan. A brief presentation of the

documentary evidence for the presence of each of the groups follows and is based primarily on information provided by Hinshelwood 1984; Meyer 1993; Mott 1938; Wedel 1974; Wilford 1937a, 1960; Winchell 1911).

Figure 2-4 is a modified map drafted by N. H. Winchell in 1906 and published in Winchell (1911) that shows the distribution of known historic tribes in a portion of the study region in the 1860s.

The Siouan Groups

The Siouan language family historically consisted of four subdivisions: Southeastern (Ofo, Biloxi, Tutelo, Catawba, Woccon - all extinct); Mississippi Valley (Chiwere, Dhegiha, Dakota); Mandan; and Missouri River (Crow-Hidatsa) (Chafe 1976; Hollow and Parks 1980; Rood 1979). Other linguistic analyses (Springer and Witkowski 1982) divide the language family into three subdivisions, the Eastern, Central, and Western. These groups correspond roughly with the Southeastern (Eastern), Mississippi Valley and Missouri River (Central). Relevant to the study region the Mississippi Valley- Central group is of primary importance. The Chiwere-Winnebago group within the Central subdivision consists of the Iowa, Oto, Missouria, and Winnebago. The Dakota subdivision consists of the Assiniboine, Teton, Yankton, and Santee. The Proto-Siouan language family is believed to have its origins in the Central Mississippi Valley (Springer and Witkowski 1982).

The Assiniboine. The Assiniboine belong to the Central subdivision of the Siouan language family and are believed to have split from the Dakota sometime during the late prehistoric or early historic period (Bushnell 1927; Lowie 1910; Springer and Witkowski 1982). Of primary importance to their location and the location of neighboring groups is

Figure 2-4. Distribution of Historic Tribes in Minnesota in 1680. (Modified from Winchell, N. H. (1911) *The Aborigines of Minnesota*. Minnesota Historical Society, St. Paul).

the alliance between the Assiniboine and the Cree and their joint antagonism toward the Dakota. These relationships, including the continual warfare with the Dakota, had great impact on the distribution of tribal groups and their relationships with the various fur trade interests (e.g. French, British). Numerous attempts were made by the fur-traders to reconcile the warring groups. Sieur du Luth (Duluth), "a free, unlicensed fur-trader...in order that the peace which they contracted might be lasting...induced the nations to make reciprocal marriages..."(Winchell 1911:524).

Primary documents suggest location of the Assiniboine near Duluth circa 1680 (Cross 1938). During the next 40 - 60 years they migrated north and west. The territory of the Assiniboine, along with the Cree and Dakota, is indicated on three early maps (see Hinshelwood 1984:85-89) dated as 1728, 1737, and 1740. In 1728, the Auchagah map (named for the Cree chief Auchagah) placed the Assiniboine southwest of Lake Winnipeg and the Winnipeg River. Their location shifted very little between 1728 and 1740. The 1737 and 1740 maps thought to be constructed from information collected by La Verendrye during his tenure in the Boundary Waters area between 1728 - 1744, locate the Assiniboine in the area between the Assiniboine and Saskatchewan rivers in Manitoba west of the Manitoba lakes. During the late 1700s and early 1800s, the Assiniboine continued their westward migration. They are believed to have left the Red River region by 1800 A.D. and occupied territories in present-day Montana, North Dakota, western Manitoba, and Saskatchewan (Hlady 1964, 1970).

Several hypotheses regarding the prehistoric ancestors to the Assiniboine have been investigated but identification of the prehistoric-historic Assiniboine continuum remains elusive. One persistent hypothesis is that the Assiniboine are descendants of the Late

Woodland Blackduck phase which occupied contiguous portions of northern Minnesota, northwestern Ontario, and southeastern Manitoba (Hlady 1964, 1970; MacNeish 1958; Ossenberg 1969, 1974; Vickers 1947, 1948; Wilford 1945a, 1955). Other researchers have disputed this association (Evans 1961b; Hinshelwood 1984;Wright 1963, 1965, 1968a, 1968b). Hinshelwood (1984:176) summarizes his perspective on the ancestry of the Assiniboine by stating, "The identification of a precontact culture attributable to the Assiniboin remains a problem for future research."

The Dakota (Sioux) Nation. The populous and widespread Dakota (Sioux) Nation is historically represented by the "Seven Council Fires". Three divisions have been identified within this structure: the Teton Lakota (Western), Santee Dakota (Eastern), and Yankton Nakota (Northern). Within each division are between two and seven subdivisions (Grobsmith 1990). According to Reverend Samuel W. Pond, a missionary in the region during the early to mid-1800s, "There were frequent intermarriages between these divisions of the Dakotas, and they were more less intermingled at all their villages. Though the language, manners and dress of the different divisions were not all precisely alike they were essentially one people" (cited in Winchell 1911:71). Relative to the study region, five of these subdivisions assume greater significance since they were identified as having been in Minnesota at the time of European contact (G. Anderson 1980; Meyer 1993; Winchell 1911) and their late prehistoric counterparts are hypothesized to have preceded them in the same region (Johnson 1985; Michlovic 1985).

The Eastern (Santee) Dakota. The Eastern Dakota, commonly known as the Santee, consist of four primary subdivisions: the Wahpeton, Wahpekute, Sisseton, and Mdewakanton. All four groups speak the Dakota dialect of the Siouan language. They

share linguistic and cultural affinities with the Yankton, Teton, and, to a lesser degree, the Assiniboine. It is reasonably clear that the Eastern Dakota were the most widespread group in Minnesota at the time of European (French) contact. "For at the coming of the white man the Dakotan occupied nearly the whole state, the only exception being in the the extreme northern part, where the Kilistino (or Crees), and the Monsoni, of the Algonquian tribes, appear to have had a long predominance" (Winchell 1911:69). The map showing the distribution of the Dakota in Minnesota in 1680 (Figure 2-4) indicates the Santee occupied the lake-forest region of central and northern Minnesota while the Teton and Yankton were situated west of the Santee in a large area that included the tallgrass prairies of western Minnesota to the Missouri River. The Chiwere Siouan groups, Iowa and Otoe were located in the southeastern quadrant of the state (Winchell 1911:68).

Although the earliest recorded meeting between the Santee and European explorers is the oft repeated rendevouz of 1660 at a village located near Hayward, Wisconsin between French explorers Pierre Esprit Radisson and Medard Chouart Sieur des Groseilliers, the Santee and many other native groups, the Santee are mentioned as present in the area in the Jesuit *Relations* as early as 1640. A few days after the initial meeting in 1660, a larger gathering, including 18 nations and the two French traders, took place to celebrate the Feast of the Dead. At this time (1670s) the highest concentration of Santee peoples was in the Mille Lacs Lake area. Journals, letters, and experiential accounts of explorer Daniel Greysolon, Sieur du Luth (Duluth) and missionary Father Louis Hennepin mark the first European visitors to this area (Meyer 1993).

During the succeeding 200 years the Santee, as well as the Teton and Yankton,

migrated south and west as a result of a number of possible factors including intertribal warfare with the Cree, Assiniboine, and most significantly with the Ojibwa, environmental amelioration/degradation, population pressure from the north and east due to the increasing competition for political and economic relationships with the French fur trading posts, and/or continuation of adaptation to and utilization of the natural resources of the tall-grass prairie (G. Anderson 1980; Howard 1972; Meyer 1993; Michlovic 1985; Winchell 1911). Migration out of the lake-forest biome was "hastened" by loss of the Mdewakanton village at Kathio following a three-day battle with the Ojibwa in 1750 (Meyer 1993; Winchell 1911). Principal settlements on Sandy, Cass, Winnibigoshish, Leech and Red lakes also fell to the Ojibwa during this period. By the end of the 18th century, following this intense period of warfare with the Ojibwa, at least the Mdewakanton subdivision of the Santee "transformed from a typical tribe of the Eastern Woodlands culture to a people at least on the margins of the Plains Indian culture to which the western Sioux became thoroughgoing converts" (Meyer 1993:14). A map drafted from 1834 illustrates the shift in settlements.

It is not surprising, given their location according to numerous maps drafted in the seventeenth, eighteenth and nineteenth centuries, that all groups (Santee, Yankton, Teton) exploited resources in both the prairie and lake-forest biome (Hinshelwood 1984; Howard 1972; Johnson 1985; Meyer 1993; Michlovic 1985; Winchell 1911). Despite displacement from their woodland home, the Santee, particularly the Mdewakanton, maintained a semi-sedentary annual cycle that mirrored their practices in the lake-forest region. "They hunted deer and other timber game, they depended partly on fishing, they gathered wild rice they still used the canoe...and horses were owned by only a minority of

families, at least among the Mdewakantons. The transition to the plains culture that had been accomplished by the Tetons, Yanktons, and Yanktonai was only begun among the Santees" (Meyer 1993:22-23). The Sisseton and Wahpeton bands of the Santee likely moved west of the Mdewakanton into the Minnesota River valley and onto the Plains proper. The Wahpekutes became nomadic, and appeared to concentrate around the headwaters of the Des Moines River (Meyer 1993).

Once relations commenced with the United States in the early 1800s, the objectives of the explorers and military personnel changed. Military officers such as Leutenant Zebulan Pike, Major Stephen H. Long, and Indian agent Major Taliaforna conducted surveys that provided information on the location of many Santee villages and facilitated meetings at which treaties were proposed and signed ceding land held by the Santee. Each United States representative also sought to end the hostilities and constant warfare between the Dakota and Ojibwa. None were successful in this objective and in 1835 a boundary between the central and northern territory of the Ojibwa and the southern and central territory of the Santee was surveyed. This attempt at demarcating the two territories had little impact on the continual raiding. Hostilities between the two groups did not cease until the many of the Santee were relocated following what has become known as the Dakota/Sioux Uprising after which 27 Dakota warriors were hung in Mankato, Minnesota (Meyer 1993; Winchell 1911).

A strong case has been made by Johnson (1985) in support of the late prehistoric Kathio phase as ancestral Santee, more precisely, the Mdewakanton. The Santee Dakota are represented in the current study by cranial samples of undifferentiated Santee, Mdewakanton, and Sisseton/Wahpeton individuals.

The Yankton (Lakota) and the Teton (Nakota). The Yankton and Teton are representatives of the seven Council Fires of the Sioux Nation (Grobsmith 1990). The Yankton are often referred to as the "Western Sioux" and speak the Lakota dialect. The Teton are the "Northern Sioux" and speak primarily the Nakota dialect. By 1700, the western groups were recognized as sufficiently distinct from the eastern to cause Le Sueur to refer to them as the "Scioux of the West" and the "Scioux of the East" (Cross 1938). As mentioned previously both are related to the Santee linguistically and culturally and it is reported that they frequently visited their eastern neighbors as well as intermarried with them (Le Sueur, 1840, in Winchell 1911). Such a situation suggests generally friendly relations between the three groups.

Early sources identify the Yankton and Teton as occupying the prairie areas of what is currently western Minnesota and the eastern Dakotas (see Hinshelwood 1984; Michlovic 1985; Winchell 1911). By 1660 "Western divisions [of the Sioux] had begun to wander onto the plains from their Minnesota homeland in pursuit of buffalo and across the Missouri River by 1750" (Grobsmith 1990:178). Indeed in a map drafted in 1906 by Nevin H. Winchell, state geologist of Minnesota, entitled, *Distribution of the Dakota in Minnesota at the Time of Hennepin. 1680. Based on History and Tradition.* locates the "Titonwan" (Teton) near the Minnesota/South Dakota border around Traverse and Big Stone lakes and the "Ihanktonwan" (Yankton) in the southwestern corner of the state, as well as in west - central Minnesota. All but a small portion of the territory occupied by these two groups during the late 1600s is located in the long-grass prairies of Minnesota (Winchell 1911:68). Others, including Pere Louis Hennepin, Charles Pierre Le Sueur, and Pere Allouez (cited in Michlovic 1985; Winchell 1911) reported on the southern and

western groups as nomadic prairie hunters early in the historic period. A second map drafted by Winchell in 1906, entitled *Distribution of the Dakota in Minnestoa in 1834 According to S.W. Pond,* indicates that some migration south and west had occurred since 1680. The Sissiton (Sisseton), Warpetonwan (Wahpeton), Warpekute (Wahpekute), and M'Dewakontonwan (Mdewakanton) bands of the Santee were all located in the southern quarter of the state and the Ihanktonwan (Yankton) group previously located in west-central Minnesota had shifted west and a bit south. The absence of the Teton and the Yankton group on the 1834 map suggests they had migrated west into the Dakotas; this situation is supported by other sources (see summaries of primary historic documents cited and discussed in Anderson 1980; Howard 1972; Michlovic 1985). The summary presented above strongly suggests that these groups were well adapted to a prairie environment and had been present in the area for some time. Indeed, there is some evidence that some of the late prehistoric sites excavated in the Red River Valley, North Dakota, and southeastern Manitoba may be ancestral Siouan (Gibbon 1995; Meyer and Hamilton 1995; Michlovic 1985; Syms 1979). A direct ancestor-descendant relationship, however, has not been established for either the Yankton or the Teton.

The Yankton are represented in the current study by a cranial sample of Yankton from South Dakota. The Teton division of the Sioux is represented by cranial samples from a group of Teton undifferentiated at the band level and a group of Oglala individuals.

The Chiwere Siouan (Iowa, Oto, Missouria, Winnebago/Ho-Chunk). Based on lexical similarity figures and counter indication scores, the divergence of the Chiwere group from the Dhegiha is estimated to have occurred somewhere around 1000 A.D.

(Springer and Witkowski 1982). Within the Chiwere, the Winnebago and Iowa-Oto-Missouri dialects subsequently diverged by 1500 A.D. The close correspondence of the distribution of the Chiwere Siouan groups and sites of the Oneota Aspect has long been interpreted to indicate an ancestral-descendant relationship between the two (Griffin 1937; Keyes 1927; McKern 1939, 1945 ; Mott 1938; Wedel 1986). More recent work indicates, however, that "there is a growing realization that Oneota itself cannot be restricted to the Chiwere-Siouan linguistic pool, which presently is being engulfed in a much larger ocean. The Oneota tradition as defined by Hall, the Wedels, and others (Hall 1962:106) is now too broad in space and time to be a simple one-to-one correspondence between Chiwere-Siouan speakers and Oneota ceramics" (C. Mason 1976:341).

The locations and migrations of the Iowa are the best known of the Chiwere-Winnebago groups, primarily as a result of the careful translation, examination, and interpretation of early historic textual and cartographic documents conducted by Mildred Mott Wedel between 1938 and 1986 (Mott 1938; Wedel 1961, 1972, 1974, 1976, 1978, 1981, 1986) relative to the Iowa, Oto, and Omaha. The tenure of the Chiwere groups in the focal area of the study region during the historic period is brief (Winchell 1911). The first report of people that are possibly the Iowa is in 1656 or 1657 when Nicholas Perrot observes a number of groups hunting bison in present-day southeastern Minnesota near the Upper Iowa River (Wedel 1986). Their continued occupation of this region is confirmed on maps drawn from information provided by Louis Jolliet and Father Jacques Marquette during their 1673 journey down the Mississippi River below the Wisconsin (Winchell 1911). The first actual encounter between a European/Frenchman occurs in 1676 during Father Louis Andre's visit to a Winnebago village located near the "De Pere

mission on Fox River south of Green Bay" (Wedel 1986:14). Increased direct contact with traders followed beginning with Michel Accault, directed by Robert Cavelier de La Salle to explore trading possibilities in the Illinois and Mississippi river country, in 1678 and 1679. Interaction with the French traders continued through the 1680s when the Iowa are reported to be in residence in southeastern Minnesota in the "Little-prairie" area and near the Zumbro River. The Little-prairie was "the main hunting ground of the Ioways and Otos from possibly the 1650s, or earlier, into the 1680s and 1690s, was evidently the upland prairie west beyond the headwaters of the western Mississippi River tributaries in present-day southeast Minnesota, between the heads of the Upper Iowa and Cedar rivers and the lower course of the Minnesota River to the north" (Wedel 1986:23). Figure 2-4 (Winchell 1911:68) illustrates their location at about this time. As a result of intertribal tensions related to the French fur trade, the Iowa were the victims of numerous raids by neighboring Siouan groups and by the late 1680s moved their semi-permanent villages west, near Spirit Lake in northwest Iowa. This area was closer to the territory of the Oto, now settled along the Missouri River, and, therefore, offered some hope of a more secure home (Wedel 1981). Le Seuer, in 1700, was informed that the Iowa village at Spirit Lake had been deserted from some time and that Iowa had migrated even further west to join the Omahas who were thought to be living on the Big Sioux River near Blood Run Creek in Iowa.

The locations and movements of the Oto and Winnebago are less completely and reliably known. Early records seem to frequently link the Oto with the Iowa in terms of lifestyle and location (Mott 1938; M. Wedel 1981; 1986). They are frequently observed to have been situated in territories close to the Iowa, but somewhat to the south and/or

west of them. In the latter half of the seventeenth century they are identified as having occupied lands in present-day southeastern Minnesota, in the vicinity of the Upper Iowa River. It is clear that by the late 1600s the Oto and the Iowa were present in the area of Spirit Lake and Lake Okoboji in northwest Iowa, and by1701 A.D. joined their friends and allies, the Omaha, on the Missouri. "We learned that the Ayavois [Iowa] and the Otoctatas [Oto] have gone to establish themselves toward the river of the Missouri, in the neighborhood of the Maha, a nation that lives in this region" (La Harpe 1831:61-62 cited in M. Wedel 1981:4). During the period between 1701 and 1757, the Oto appear to be present in the area on the west side of the Missouri River and after 1757, the Oto resided more permanently in the area of the Platte River (Mott 1938).

The Winnebago are not believed to have ever had permanent settlements in present-day Minnesota. They are believed to have resided in northeast Wisconsin in the vicinity of Green Bay where they are reported to have encountered Jean Nicolet in 1634 (Lurie 1960). Following this they may have moved westward to the Lake Winnebago-Fox River area where they are reported to be in 1665 when they were visited by Perrot and later, in 1676, during a visit by Father Louis Andre (C. Mason 1976; Wedel 1986). At the time of Nicolet's visit, the Winnebago were reported as sedentary, numerous, and residing in large villages, but were much reduced in number and occupying only small villages, presumably due to disease, disaster, and warfare, by the 1660s (Lurie 1960; C. Mason 1976). With the westward movement of Central Algonquian peoples during this period, the Winnebago, who remained in their traditional homeland and expanded to the south and west, were surrounded by numerous Algonquian groups. They reportedly intermarried with them and became a "people differing in only minor details of culture

from surrounding Algonkian speaking tribes" (Lurie 1960:791).

The Iowa, and presumably the Oto, lived in semi-permanent villages, occupied on a seasonal basis. Their subsistence consisted of bison hunting and corn, beans, and squash gardening. The larger villages were occupied more regularly when the gardens required more of their attention. Other times of the year they followed the bison herds and often hunted with Oto and, possibly, Winnebago parties. The Winnebago, as indicated earlier, were primarily sedentary and lived in small, scattered villages. Hunting and trapping became more important throughout the 1600s as a result of the fur trade. It has been well established that the Orr Focus of the Oneota Aspect represent the protohistoric Iowa (Keyes 1927; Mott 1938; Wedel 1976) and Dobbs (1984:218-229) makes the argument that some of the Blue Earth Oneota may be ancestral Oto. The prehistoric and proto-historic Winnebago are debated at this point. Earlier researchers (Griffin 1960; Keyes 1937; McKern 1945) postulated a direct historic link between the Lake Winnebago Oneota and the historic Winnebago. More recently, however, this idea has been challenged with the realization that "the actual evidence upon which this identification originally was made is so slim as to be almost nonexistent" (C. Mason 1976:348). Current hypotheses explore other possibilities for the proto-historic Winnebago, such as segments of the Oneota Orr focus (C. Mason 1976) and prehistoric Winnebago, including, once again (see McKern 1945; Radin 1916) the idea that the Late Woodland Effigy Mound Culture represents early Winnebago (Hall 1993).

The Iowa and Oto are not represented in the current study sample due to the absence of existing skeletal, and specifically, cranial samples (Myster and O'Connell 1997). The Winnebago are represented in the study sample by individuals from South Dakota and

Wisconsin.

The Algonquian Groups

Algonquian is a large language family widely spread across North America. It is divided into three primary groups: Eastern, Central, and Plains that tend to reflect geographic distribution (Goddard 1978). Relevant to the current study are the Central and Plains Algonquians. The Central group consists of seven languages within which there may be local dialects. Central Algonquians include the Cree, Ojibwa, Potawatomi, Menomini, Fox, Miami-Illinois, and Shawnee. The Plains Algonquian group consists of three distinct languages, Blackfeet, Cheyenne, and Arapaho. The Ojibwa, Cree, and Cheyenne are believed to have occupied territories within the study region.

The Cheyenne. Reconstructing the origins of the Cheyenne has engendered considerable debate. Much of the debate centers in the disciplines of historical linguistics and archaeology. It can be agreed, however, that "throughout its history the Cheyenne nation has exhibited significant variability in culture, language, and social structure" and that "certain fundamental empirical questions about their history, migrations, and social structure are still unanswered" (Moore 1987:2-3). Linguists have focused on the development and branching of the Algonquian language (Goddard 1978; Pentland 1978; Siebert 1967; Snow 1976) from a Proto-Algonquian parent language. The Cheyenne, Blackfeet, and Arapaho comprise the Plains Algonquian group. Two other dialect groups, Central and Eastern, comprise much of the remainder of this large language family. The Cheyenne are linguistically distinct from the Arapaho and the more geographically proximate Central Algonquian groups (including among others the Cree and Ojibwa) (Pentland 1978).

The Cheyenne are first referred to on a hand-drawn manuscript map by Jean-Baptiste Franquilin in 1674 based on information reported by Louis Joliet (Moore 1987). "They are here called "Chaiena" and are listed together with seven other tribes on the east side of the Mississippi River some distance above the Wisconsin ... placed in western Wisconsin, just over the border of southeastern Minnesota" (Jablow 1951:2). A later map by Franquelin, drafted in 1688, places the Cheyenne on the northwestern section of the Minnesota River (Jablow 1951). This location is also recorded on a map in Winchell (1911:68) that reflects the locations of various tribes at the time of Father Louis Hennepin and Sieur Le Sueur circa 1680. They Cheyenne are also observed to occupy the Mississippi near the headwaters on a manuscript map drawn by Hennepin in 1697 (Moore 1987). By 1700 the Cheyenne are noted to have occupied at least one site (Biesterfeldt) on the Sheyenne River (Grinnell 1972; Jablow 1951; Moore 1996; Winchell 1911). "When Le Sueur, in October of 1700, founded his post at the mouth of the Blue Earth River on his journey up the Minnesota, he met 'nine Scioux, who told him that the river belonged to the Scioux of the West, The Ayavois (Iowa), and Otoctatas (Oto), who lived a little farther off, ...' The fact that the Cheyenne are not mentioned in this connection, when taken together with the information provided by Franquelin's map of 1688, would seem to bear out the inference that they had probably moved up the Minnesota to Big Stone Lake and Lake Traverse, and thence up the Red River from which they branched off at the Sheyenne where Franquelin's later map places them by 1700" (Jablow 1951:3). Moore's (1987) excellent work reconstructing Cheyenne origins and migrations, also concludes that by 1710 the Cheyenne and closely allied groups appear to have left the north-central area around the source of Mississippi River; his *Map*

4 illustrates the locations of Cheyenne villages and pattern of westward migration from 1680 to 1805 (Moore1987:83) . Other explorers and missionaries record encounters with the Cheyenne in the latter half of the eighteenth century on the Minnesota River practicing at that time a more migratory lifestyle with an emphasis on buffalo hunting.

Prior to their westward migration to the Sheyenne River and later the Missouri (c. 1700/1710), the Cheyenne practiced a semi-sedentary horticultural lifestyle. "We may thus visualize the Cheyenne in the second half of the seventeenth century as small Algonkian-speaking, horticultural groups, neighbors on the Minnesota River of horticultural Siouan tribes..." (Jablow 1951:6). This settlement pattern was practiced by some bands until approximately the 1770s when they became more dedicated to a fully equestrian, nomadic settlement pattern and moved further west and south of the Missouri River near the Mandan (Strong 1940). Their conversion to a traditional and typical Plains adaptation, however, did not occur wholesale. Grinnell (1972:14-15) states that "it is probable that at the time when some of their villages were permanently situated at certain points, a part of the Cheyennes were still pushing westward, and that the tribe was partly migratory and partly sedentary, some established in one place and some moving about. It is possible that the permanent villages on the Yellow Medicine River in Minnesota, and on the Cheyenne River in North Dakota, and perhaps others, were occupied during the same period, that even at this time there may have been a settlement of Cheyennes on the Missouri River, and that other groups may then have been wandering on the plains after the buffalo."

The prehistoric ancestors of the Cheyenne remain elusive though several researchers have presented hypotheses identifying the archaeological complexes most likely to have

transformed into the historic Cheyenne (Michlovic 1977 et al.; Ossenberg 1974; Schlesier 1987; Syms 1982). Schlesier (1987, 1994) proposes the Besant culture, followed by Arvilla were ancestral to the Cheyenne. This view, to be discussed in greater detail in Chapter 5 is supported by Ossenberg's (1974) biodistance study. Syms (1982), while refraining from identifying a specific ancestral archaeological complex, does state that it is most likely that the groups ancestral to the Cheyenne were Algonquian-speakers. Michlovic et al. (1977) disagree with the proposed Arvilla-Cheyenne continuum. Citing ethnohistoric data they explain the unlikelihood of such a relationship, positing a Siouan-speaking ancestral group instead.

The Cheyenne are represented in the study by a cranial sample of Cheyenne from Nebraska.

The Ojibwa. The Ojibwa are the most widely distributed tribe in North America and are classified linguistically as Central Algonquian (Ritzenthaler 1978; Stone and Chaput 1978). They are more specifically identified as belonging to the Central Algonquian branch of the larger language family, a dialectic group centered in the Great Lakes region and adjacent areas in Canada (Goddard 1978; Schlesier 1994). Linguistically and culturally they are closely related to the more northerly located Cree, and the more southerly Ottawa and Potawatomi (Rogers 1978) . Hickerson (1962) suggested that by the end of the nineteenth century a four part division of this extensive group was observable. The four groups consisted of the Northern Ojibwa or Saulteaux, the Plains Ojibwa or Bungee, the Southeastern Ojibwa, and the Southwestern Chippewa. Each group occupied identifiable territories: the Northern Ojibwa were situated in the northern boreal forests of the Laurentian uplands north of the Great Lakes; the Plains Ojibwa

occupied an area in southern Saskatchewan and Manitoba; the Southeastern Ojibwa were located in Michigan along the lower peninsula and adjacent regions of Ontario; and the Southwestern Chippewa (Ojibwa) were identified in the northern half of Minnesota and the contiguous area of northern Wisconsin (Ritzenthaler 1978:743). Most relevant to the current study are those Ojibwa who eventually occupied the northeastern portion of the study region (Minnesota, northwestern Ontario, southeastern Manitoba).

According to a majority of all accounts the Ojibwa arrived in Minnesota "late" and their history within the state and overall study region is a short one (Bishop 1976; Bishop and Smith 1975; Hart 1956; Hinshelwood 1984; Ritzenthaler 1978; Rogers 1978; Wilford 1960; Winchell 1911). More recently, however, there has been a challenge to this interpretation primarily on the grounds "that the term 'Ojibwa' was applied only to a small number of Ojibwa-speakers" and further that the shifting and undefined use of "Ojibwa" in historic documents "has led to theories of extensive population movement" (Greenberg and Morrison 1982:81). They argue that "groups known today as Northern Ojibwa have inhabited the boreal forest at least since contact ..." and that "... the 'emergence' of the Northern Ojibwa was nothing more than the diffusion of the term 'Ojibwa' to ethnic units known at contact under a host of different names–among them Kilistinon or Cree, Monsoni, Muskego, and Gens des Terres" (Greenberg and Morrison 1982:75).

The geographic homeland of the Ojibwa is believed to lie northeast of the Great Lakes. Rogers (1978:760) more specifically identifies "that their homeland was somwhere within an area extending from the east shore of Georgian Bay, west along the north shore of Lake Huron, and a short distance along the northeast shore of Lake

Superior and onto the Upper Peninsula of Michigan." From there they spread west, north, and south into western Saskatchewan, southern Ontario and Winnipeg, Minnesota, Wisconsin, Michigan, and North Dakota (Ritzenthaler 1978). The Ojibwa presence in the study region is noted by many explorers and missionaries during the seventeenth, eighteenth, and nineteenth centuries (see Dawson 1987; Greenberg and Morrison 1982; Hickerson 1962; Hinshelwood 1984; Peers 1994; Wilford 1960; Winchell 1911). They are mentioned as present in the area near the study region as early as 1640 by the Jesuits when Jean Nicollet lists them as one of the bands located in the Upper Great Lakes region during his trip to visit the Winnebago in 1634. Ritzenthaler (1978) mentions that the Jesuits reported possible Ojibwa fishing camps along the southern shore of Lake Superior in the 1658 *Relations* and Winchell (1911) reports that "when Radisson and Chouart visited central Minnesota in 1659 the Ojibwa had not reached Minnesota, excepting perhaps in occasional hunting or warlike expeditions." Their undisputed presence was observed and noted in the 1736 census at Kamanistikwia and by 1740 Ojibwa groups were observed to be in residence between Saganagaw and Rainy Lake. By 1760 the predominant occupants of the Boundary Waters area were the Ojibwa (Saulteur) groups (Hinshelwood 1984). Still later in the eighteenth century, Henry and Carver encountered Ojibwa throughout the Boundary Waters area and further south (Hinshelwood 1984). The period between 1736 and 1825 saw the origins of the Ojibwa - Dakota war and the limit of Ojibwa expansion in Minnesota (Wilford 1960). This period is marked by many battles between these two groups, the end result of which was the occupation of slightly more than the northern half of Minnesota by the Ojibwa and the remainder of the state by the Dakota by 1825.

The Ojibwa were identified during the early historic period as widely scattered, semi-autonomous bands. By the nineteenth century when the division of the Ojibwa into four groups was proposed, each of the four divisions were characterized by a distinctive settlement pattern. Ritzenthaler (1978:744) summarizes each adaptation as described by Hickerson (1962:2-3): "First, the Northern Ojibwa, or Saulteaux, occupied the forests of the Laurentian uplands north of the Great Lakes. They were characterized by small, discrete, scattered bands with a hunting-fishing-gathering economy, which made little or no use of wild rice or maple sugar, and later with family hunting territories ... Second are the Plains Ojibwa, or Bungee, ... they exhibited the most radical change in adopting certain political and ceremonial traits, as well as a bison-hunting economy, from the northern Plains tribes with whom they came in contact ... the Southeastern Ojibwa ...were hunters, fishermen, gardeners, and gatherer of maple sugar, and, only in some instances, of wild rice. They were organized in somewhat larger aggregates than were the Northern Ojibwa, with relatively large summer villages ... the Southwestern Chippewa ... found a rich supply of wild rice, which became an important part of their economy. They also collected maple sugar and did some gardening, in addition to their important mainstays of hunting, trapping, and fishing."

The relationship of the historic Ojibwa to the late prehistoric groups considered in the current study is debatable. Some researchers hypothesize a Blackduck-Ojibwa continuum in the study region (Wright 1971) while others discredit this possibility due to the recent arrival (after A.D.1700) of the Ojibwa in the study region (Hlady 1971; MacNeish 1958; Wilford 1937a, 1937b, 1955). The Ojibwa are represented in the current study by individuals from Michigan, North Dakota, Minnesota, Manitoba, and

Ontario.

The Cree. In the Subarctic region, the Cree represent the northern branch (relative to the Ojibwa) of the Algonquian language family. They are closely related to the Ojibwa, however, linguistically they represent an independent development from the ancestral Proto-Algonquian language (Rhodes and Todd 1981). Cree speakers are distributed over a very wide area "including most of the Quebec-Labrador peninsula, the Hudson Bay coastal region of Ontario, central Manitoba, Saskatchewan, and Alberta (Rhodes and Todd 1981:53). Due in part to the settlement and subsistence practices of the ancestors of the Cree and the Ojibwa as nomadic hunter-gatherers there has historically been a fair amount of confusion about the names of the communities/groups of Cree and Ojibwa speakers. This situation is recognized as possibly having affected the accuracy of early accounts that identify tribal affiliation of encounters with these peoples (Greenberg and Morrison 1982). For this reason, as well as the discontinuous presence of early explorers and missionaries in Cree territory, the location and overall distribution of the Cree is difficult to define. "... (T)hey seem to have occupied lands surrounding James Bay and along the western shores of Hudson Bay, north almost to the Churchill River where they bordered on the Inuit. Their territory appears to have extended as far as Lake Winnipeg to the west and Lake Nipigon to the south. Seventeenth-century accounts indicated that they frequently visited the northern shores of Lake Superior, and on a number of occasions they were reported to have been fishing at Sault Ste. Marie as guests of the Ojibwa" (MacMillan 1988:101).

Hinshelwood (1984), Bishop (1981), and Bishop and Smith (1975) discuss the earliest accounts of Cree groups in the Boundary Waters area and the region west of

James Bay and north of Lake Superior, respectively. Early cartographic and narrative documents indicate the inhabitants of these regions were small, widely distributed Cree bands. The Jesuits in the *Relations* of 1640 report that they "dwell on the rivers on the north sea [James Bay] where Nipissings go to trade with them" (cited in Bishop 1981:158). Two decades later, in 1660, Nicolas Perrot states the the Kilistinons (Cree) "often frequent the region along the shores of Lake Superior, and the great rivers, where moose are commonly found" (cited in Bishop 1981:158). Still later, Father Marquette reports that the "Christinaux" (Cree) continue to travel to the north shore of Lake Superior during the summer months. It is Bishop's interpretation of the documentary evidence that the Cree were in residence along the international border by the time the French explorers arrived. Bishop (1981:158), in consideration of the confusing mix of Cree and Ojibwa bands during the seventeenth century, concludes that "it is not possible to determine the exact geographical demarcation between the Cree groups living nearer Lake Superior and the neighboring non-Cree groups, the Ojibwa and Algonquian proper to the southeast and the Siouan-speaking Assiniboine to the southwest."

Towards the beginning of the eighteenth century, documents and maps clearly identify the Cree as present in the Boundary Waters area and just north of this region (Hinshelwood 1984). The Auchagah map of 1728 places the Lake Nipigon Cree groups in the area between Lake Nipigon and Rainy Lake, as well as north of Rainy Lake, Lake-of-the-Woods, and the Winnipeg River. The Cree bands continued to move west throughout the first half of the eighteenth century identified in 1732 around Fort St. Charles on Rainy Lake, in the vicinity of Lake-of-the-Woods in 1740, and, in addition to settlements around Lake-of-the-Woods, along the Winnipeg River by 1752. By 1760, the

Ojibwa were the primary occupants of the Boundary Waters region. Jonathan Carver and Alexander Henry (senior) noted Cree communities at the lower end of Lake Winnipeg and at the mouth of the Winnipeg River, respectively, in the last quarter of the eighteenth century. Use of the Boundary Waters area by the Cree to hunt and fish following Ojibwa settlement, however, continued throughout the 1700s and most likely the 1800s up to the Reservation period. Throughout the early historic period, it is clear that the Cree, Ojibwa, and the Siouan-speaking Assiniboine, were in close proximity to one another and interacted frequently during the course of transporting furs to the various posts, raiding the Dakota to the south, and for subsistence purposes.

The prehistoric ancestors of various bands of the Cree are believed to lie west of the study region within the Selkirk horizon, A.D. 1100 - European contact (Meyer and Hamilton 1994; Meyer and Russell 1987; Wright 1971). Given this, the Cree are unlikely to be closely related to the archaeological cultures represented in the study sample. However, some researchers posit an Assiniboine identification of the Late Woodland Blackduck phase (Hlady 1964; MacNeish 1958; Wilford 1937a, 1937b, 1955) while others argue the Ojibwa are the most likely descendants of the Blackduck phase (Wright 1965, 1971). Given the close relationship between the Assiniboine, Ojibwa, and Cree, it might be expected that the Cree would, in fact, not be that distant from, at least, the Blackduck cranial sample. The Cree are represented by a single individual from southeastern Ontario.

CHAPTER 3

MATERIALS AND METHODS: CRANIAL SERIES, VARIABLE SELECTION AND STATISTICAL ANALYSIS

Cranial Series

The assembly of a cranial series that is temporally and spatially representative of the study region, well-documented as to context and date, and comprised of reasonably complete and numerous crania is necessary to accomplish the research objectives detailed in Chapter 1. To facilitate an understanding of the broad picture of population relationships and group distribution patterns, the study sample is constructed to include crania from Minnesota as well as from areas bordering the state that represent extensions of the territories occupied by the early Minnesota groups, as well as archaeological cultures believed to have close affinities to some of the Minnesota groups. For this reason, all reasonably complete crania from the entire state of Minnesota were measured, as were certain samples from Nebraska and contiguous areas in North and South Dakota, Iowa, and the Canadian provinces of Ontario and Manitoba (see Figure 1-3). The cranial series consists of a base of 380 individuals, 306 of which are sufficiently complete to include in the current analysis.

The skeletal series includes individuals from sites dating from the Paleoindian period through post-European contact. Appendix 1-1 lists the sites included in the analysis, collection accessibility, and primary site references. All crania included are reliably identified as to site, taxonomic classification, and time period. "Reliably identified" is

somewhat of a misnomer in Minnesota archaeology since so few sites with mortuary components have been radiocarbon dated (Table 3-1). Assignment of human remains to an archaeological period are most frequently based on ceramic types and mortuary patterning. While designations based on such tenuous associations are less than ideal, it is the current state of knowledge for many mortuary sites. The evidence presented for each site designation was assessed and a determination of reliability was made. Undoubtedly, there will be disagreement with some of the site classifications, however, the multivariate statistical method applied in the forthcoming analysis requires an *a priori* group structure. Due to the lack of any contextual evidence, a small number of sites are categorized more broadly as to period (e.g., Late Woodland). One benefit of the current analysis is that it may shed some light on the degree of biological homogeneity that characterizes the defined archaeological cultural manifestations, as well as a likely taxonomic identification.

Environmental, cultural, and socio-political factors affect the completeness of available crania and, therefore, overall samples sizes for each phase. Environmental factors, including breakage, natural deformation (i.e. warping), and deterioration due to burial environment resulted in the exclusion of numeous crania from consideration. Fragmentation was, at times, extreme enough to preclude reconstruction. Cultural practices of a number of prehistoric groups, primarily postmortem body preparation and modification and the occurrence of isolated burials, affected inclusion of crania and overall sample size. A number of groups, including Malmo, Howard Lake, and Kathio frequently practiced secondary burial, following either initial placement of the deceased on scaffolds or in trees, cremation, or transportation with the group for a period of time

Table 3-1. Radiocarbon Dates for Minnesota Mortuary Sites.

Site (Number)	Sample	Material	RCBYP	Reference
Browns Valley	NZA-1102	Human Bone	8790 ± 110	Shane 1991
(21TR05)	NZA-1808	Human Bone	9049 ± 82	Shane 1991
Bryan	I-781	Charred Wood	825 ± 150	Johnson 1964
(21GD04)	I-782	Charcoal	760 ± 90	Johnson 1964
	I-783	Charcoal	500 ± 120	Johnson 1964
	Beta-8840	Charcoal	740 ± 50	Dobbs 1984
	Beta-8841	Charcoal	870 ± 50	Dobbs 1984
	Beta-8842	Charcoal	920 ± 50	Dobbs 1984
	Beta-8843	Charcoal	780 ± 100	Dobbs 1984
	Beta-8844	Charcoal	840 ± 70	Dobbs 1984
	QL-4491	Charcoal	858 ± 13	Dobbs 1992
	QL-4492	Charcoal	820 ± 16	Dobbs 1992
	QL-4493	Charcoal	875 ± 15	Dobbs 1992
	QL-4494	Charcoal	833 ± 15	Dobbs 1992
	QL-4489	Charcoal	883 ± 16	Dobbs 1992
	QL-4490	Charcoal	831 ± 16	Dobbs 1992
	QL-4495	Charcoal	828 ± 16	Dobbs 1992
	QL-4496	Charcoal	861 ± 17	Dobbs 1992
	QL-4497	Charcoal	840 ± 15	Dobbs 1992
	QL-4498	Charcoal	846 ± 19	Dobbs 1992
	QL-4599	Charred Corn	770 ± 15	Dobbs 1992
	QL-4500	Charcoal	839 ± 21	Dobbs 1992
Cambria	GX-6778	Charcoal	815 ± 125	Shane 1981
(21BE02)	GX-6779	Charcoal	775 ± 130	Shane 1981
Crookston	I-793	Charred Wood	Modern	Johnson 1964
(21PL09)				
Femco	?	Charcoal	2400 ± ?	Michlovic pc, 1990
(21WL01)				
Haarstad	I-778	Bone	1165 ± 120	Johnson 1964
(21MA06)	I-780	Shell	3200 ± 190	Johnson 1964
Lake Bronson	I-9725	Charcoal	1745 ± 85	Anfinson et al. 1978
(21KT01)	Beta-1077	Charcoal	1425 ± 70	Anfinson pc, 1979
McKinstry	WIS-471	Bark	1700 ± 55	Stoltman 1974
(21KC02)	WIS-486	Charcoal	1980 ± 45	Stoltman 1974
	WIS-487	Charcoal	1940 ± 60	Stoltman 1974
	WIS-489	Charcoal	1830 ± 55	Stoltman 1974
	WIS-490	Charcoal	1390 ± 55	Stoltman 1974
	I-789	Charred Bark	475 ± 110	Johnson 1964
	I-796	Bark	760 ± 90	Johnson 1964
	Beta-9430	Charcoal	2260 ± 120	Peterson pc, 1989

Table 3-1 (continued).

Site (Number)	Sample	Material	RCBYP	Reference
McKinstry (cont.)	Beta-12516	Charcoal	2250 ± 70	Peterson pc, 1989
Morrison Mound (21OT02)	I-787	Charred Wood	2640 ± 200	Johnson 1964
Pelican Rapids (21OT03)	CAMS-6380	Human Bone	7840 ± 70	O'Connell and Myster 1996
Rooney Mound (21PO13)	?	Human Bone	~ 4000	Myster and O'Connell 1997
Round Mound (21TR01)	I-791	Wood	1025 ± 100	Johnson 1964
Schocker (21BL01)	I-797	Bark	Modern	Johnson 1964
Voight (21WN15)	?	Human Bone	2557 ± 52	Myster and O'Connell 1997
Vosburg (21FA02)	I-795	Charcoal	160 ± 85	Johnson 1964b
	GX-6780	Charcoal	670 ± 140	Shane 1981
	GX-6781	Charcoal	675 ± 140	Shane 1981
	GX-6782	Charcoal	345 ± 140	Shane 1981
	GX-7032	Charcoal	585 ± 105	Shane 1981
	GX-7033	Charcoal	525 ± 125	Shane 1981
	UGA-4123	Charcoal	835 ± 80	Dobbs 1982
	UGA-4124	Charcoal	1035 ± 80	Dobbs 1982

after death. Additionally, the Blackduck, Arvilla, Kathio and some of the unclassified Woodland remains, were subject to intentional postmortem modification of the crania and long bones (Keaveny et al. 1993; Torbenson et al. 1996; Wilford 1937a, 1937b). The postmortem modification that is commonly practiced in the Upper Midwest is termed "tapping" and results in the removal of most of the occipital squama (affecting the lambda and asterion landmarks), the basicranial region of the skull (frequently including

the basion and opisthion landmarks), and, less frequently, portions of the parietal bones (precluding maximum breadth measurements) of the skull. Needless to say, while this is an interesting practice that may reflect interaction between groups through shared cultural practices, the number of measurements affected by such a practice can be great depending on the location and extent of the tapping. The occurrence of isolated burials, in some instances, results in sample sizes as small as one (e.g. Browns Valley, 21TR05; Pelican Rapids, 21OT03). Such small sample sizes impact the Early Prehistoric period most significantly. Finally, what will here be called "socio-political" factors, affected access to skeletal collections of the Laurel, historic Ojibwa, and some Blackduck. In the case of the Laurel and Blackduck remains from the Smith (21KC03) and McKinstry (21KC02) mound sites (approximately 350 individuals), reburial occurred prior to completion of an exhaustive osteological analysis, including metric and nonmetric analysis of the crania, postcrania, and teeth. Adherence to the regulations and intent of NAGPRA has resulted in changes to institutional policies regarding access to many collections of historic American Indian remains currently housed at museums across the country. A sample of historic Ojibwa remains recovered from Ontario were unavailable for measurement as a result of this situation.

The Prehistoric Series

The prehistoric cranial series consists of 194 individuals (63.4% of the sample) representing 16 of 25 defined phases 64% (see Table 2-3). As described in Chapter 2, the crania are organized into various taxonomic levels, by Period, Tradition, Variant, Phase, and Site. The Phase is the primary category of analysis and 61 sites are distributed among 16 phases plus two "Unknown" phases. Table 3-2 presents the taxonomic

Table 3-2. Prehistoric Cranial Series Organized Within Taxonomic Categories Defined by the Archaeological Framework.

Period	Tradition	Variant	Phase	Site Name	Site No.	Sample Size Male	Female	Total
Early Prehistoric	Paleoindian	Paleoindian	Lanceolate Pattern	Browns Valley	21TR05	1	0	1
	Archaic	Archaic	Prairie	Pelican Rapids	21OT03	0	1	1
				Rooney Mound	21PO13	1	0	1
				Clitherall	21OT78	1	0	1
				Sauk Valley	21TO01	1	0	1
				Helget	21BW82			
				Pelican Lake	21PO13			
			Eastern	Voight	21WN15	2	2	4
EARLY PREHISTORIC SAMPLE SIZE						***6***	***3***	***9***
Middle Prehistoric	Woodland	Early/Initial	Unknown	Morrison Md.	21OT02	2	2	4
		Unknown	Unknown	Noyes	21PO14	1	0	1
		Unknown	Sonota	Swift Bird	39DW233	1	2	3
				Grover Hand	39DW240	1	1	2
				Arpan	39DW252	3	1	4
				Boundary Md.	32SI01	1	0	1
				Total Sonota		6	4	10
MIDDLE PREHISTORIC SAMPLE SIZE						***9***	***6***	***15***
Late Prehistoric	Woodland	Late Woodland	Unknown	Crookston Md.	21PL09	5	0	5
			Unknown	Round Mound	21TR01	2	2	4

Table 3-2 (continued).

Period	Tradition	Variant	Phase	Site Name	Site No.	Sample Size Male	Female	Total
Late Prehistoric, cont.								
			Unknown	Brostrom	21WB01	0	1	1
			Total Late Woodland, Unknown Phase			7	3	10
			Blackduck	Schocker	21BL01	4	0	4
				Mud Lake Mds.	21CA02	1	1	2
				White Oak Point	21IC01	5	1	6
				Osufsen Mound	21IC02	4	3	7
				McKinstry Mds.	21KC02	10	2	12
				Hungry Hall Mds.	Ontario	6	5	11
				Mound Point	Ontario	2	0	2
				Oak Point	Ontario	1	1	2
				Total Blackduck		**33**	**13**	**46**
	Plains/Woodland	Late	Arvilla	Lake Bronson	21KT01	0	2	2
				Snake River Mds.	21MA01	0	1	1
				Haarstad Mound	21MA06	1	0	1
				Warner Mounds	21PL03	3	5	8
				Slininger Mound	21NR01	2	1	3
				Red Lake River Md.	21RL01	1	2	3
				Femco	21WL01	1	0	1
				Madsen Mound	39RO02	1	1	2
				Buchannon Mound	39RO03	2	4	6
				Hartford Beach Md.	39RO04	2	1	3
				Daugherty	39RO10	3	2	5

Table 3-2 (continued).

Period	Tradition	Variant	Phase	Site Name	Site No.	Sample Size Male	Female	Total
Late Prehistoric, cont.								
				De Spiegler	39RO23	4	5	9
				Total Arvilla		**20**	**24**	**44**
	Plains/Woodland	Late	Devils Lake-Sourisford	Unnamed	32RM19	0	1	1
				Forest River Mds.	32WA–	4	4	8
				Heimdal	32WE401	2	0	2
				Arden	Manitoba	1	1	2
				Darlingford	Manitoba	2	1	3
				Pilot	Manitoba	1	2	3
				Total Devils Lake-Sourisford		**10**	**9**	**19**
	Middle Missouri	Initial	Great Oasis	Ryan	25DK02	1	0	1
				Whitten	25NH04	0	1	1
				Platte-Winner	39CH54	0	2	2
				Oldham	39CH07	0	1	1
				Arbor Hill	39UN01	1	1	2
				Total Great Oasis		**2**	**5**	**7**
			Mill Creek	Broken Kettle	13PM01	2	1	3
				Kimball	13PM04	1	0	1
				Total Mill Creek		**3**	**1**	**4**
			Cambria	Lewis Mounds	21BE06	1	0	1

Table 3-2 (continued).

Period	Tradition	Variant	Phase	Site Name	Site No.	Sample Size Male	Female	Total
Late Prehistoric, cont.								
			Big Stone	Lindholm Mound	21BS03	3	4	7
				Unnamed	21BS16	2	0	2
				Total Big Stone		**5**	**4**	**9**
	Oneota	Oneota	Blue Earth	Blood Run	13LO02	2	0	2
				Correctionville	13WD06	1	0	1
				Vosburg	21FA02	3	2	5
				Total Blue Earth		6	2	8
			Orr	Flynn	13AM43	0	3	3
				Rushford Mounds	21FL09	3	0	3
				Hogback	21HU01	2	4	6
				Wilsey	21HU04	1	0	1
				Total Orr		**6**	**7**	**13**
			Vermillion Bluff	Vermillion Bluff	39CL1A	1	0	1
			Klatsulas	Klatsulas	39CL1B	1	0	1
	Mississippian	Silvernale	Silvernale	Bryan Village	21GD04	2	0	2
TOTAL LATE PREHISTORIC SAMPLE SIZE						***97***	***68***	***165***

organization and classification of the sample. Each temporal period is represented, though not equally. The Late Prehistoric period is, not surprisingly, the best represented with 169 of 194 individuals (87.1%). The Middle Prehistoric period is represented by 16 individuals (8.2%), and, finally, the Early Prehistoric period is represents 4.7% of the sample with nine individuals.

Another way to evaluate the representativeness of the sample is to assess the number of phases represented per period. Three of the five (60%) phases within the Early Prehistoric period are represented in the study sample. Unfortunately, no mortuary sites have been identified for the two Archaic phases not represented, Shield and Lake Forest. The Middle Prehistoric period is the most poorly represented with only two of the eight (25%) phases yielding measureable crania. A situation similar to the Early Prehistoric period exists, however, since mortuary sites have been identified for only five of the eight phases - Initial/Middle Woodland, Malmo, Howard Lake, Laurel, and Sonota. Of these five, the human remains from the Malmo and Howard Lake phases were too fragmentary (due to characteristic secondary burial) to include, and the human remains from the Laurel phase were reburied prior to the initiation of this research. The phases of the Late Prehistoric period are very well represented. One of three (33.3%) phases of the Late Woodland are represented Woodland, four of four (100%) Middle Missouri Tradition phases are represented, two of three (66.6%) Oneota phases/localities are represented, and one of one (100%) Mississippian phases are represented. Relative to the Late Woodland, human remains from the Kathio phase, characterized by the practice of secondary burial, were too fragmentary to yield sufficiently complete crania and few Sandy Lake mortuary sites have been excavated. A single Sandy Lake cranium,

however, has recently become available for measurement and will be incorporated into future studies. Considering the identification, or lack thereof, of mortuary sites and the characteristic mode of burial for each phase defined within Minnesota, the study sample is clearly representative of a majority of the prehistoric peoples that inhabited the study region over the last 10,000 years; the cranial sample for the Middle Prehistoric period is the least representative.

The Historic Skeletal Series

The historic skeletal series consists of 112 individuals (36.6% of the sample) from 12 American Indian tribes and bands. Tribes represented include many of those believed to have occupied areas with Minnesota during the past. Tribes/bands included for analysis are the Assiniboine, Cheyenne, Cree, Mdewakanton, Oglala, Ojibwa, Santee, Sisseton-Wahpeton, "Sioux", Teton, Yankton, and Winnebago/HoChunk. The individuals included within each tribal sample represent historic burials intrusive to prehistoric mounds, as well as those from various other historic sites. Table 3-3 details the composition of the sample representing each historic tribe. It should be noted here that the Iowa and Oto groups were clearly present in Minnesota in prehistoric times and would be an important addition to the study sample, however, no curated skeletal remains of these groups are known to exist. data were collected for the study sample, however, the emphasis of the current study is on population relationships as reflected by cranial measurements. Cranial nonmetric traits were collected by the author as was a portion of the dental nonmetric data. The majority and remainder of the dental nonmetric data was collected as part of the protocol for analysis of human remains implemented by the

Table 3-3. Historic Cranial Series Organized by Language Family and Tribal/Band Affiliation.

Language Family	Dialect	Tribal/Band	Site	Site Number or State	Sample Size Male	Female	Total
Central Siouan	Nakota	Assiniboine	Icehouse Bottom	32WI17	1	3	4
			Fort Buford	North Dakota	2	1	3
			- - -	North Dakota	1	0	1
				Total Assiniboine	**4**	**4**	**8**
	Nakota	Teton	Fort C. F. Smith	Montana	1	1	2
			Fort Union	Montana	1	2	3
			Fort Laramie	Wyoming	3	0	3
			Fort Randall	South Dakota	0	1	1
			SARC	- - -	1	0	1
				Total Teton	**6**	**4**	**10**
		Oglala	Fort Robinson	Nebraska	0	3	3
			Niobara River	Nebraska	2	0	2
			Fort Randall	South Dakota	2	1	3
			Pine Ridge Reservation	South Dakota	0	1	1
			Fort Laramie	Wyoming	1	1	2
				Total Oglala	**5**	**6**	**11**
	Lakota	Yankton	Big Bend Burials	39BF–	2	0	2
			Fort Burford	North Dakota	1	0	1
			PM	- - -	1	0	1
				Total Yankton	**4**	**0**	**4**

Table 3-3 (continued).

Language Family	Dialect	Tribal/Band	Site	Site Number or State	Sample Size Male	Female	Total
Central Siouan	Dakota	Santee	Fort Sisseton	South Dakota	2	5	7
			Fort Wadsworth	South Dakota	1	0	1
			Fort Randall	South Dakota	0	1	1
			- - -	Smithsonian	1	0	1
				Total Santee	**4**	**6**	**10**
	Dakota	Mdewakanton	Steele Md. Grp.	21SC24	1	0	1
				Total Mdewakanton	**1**	**0**	**1**
	Dakota	Sisseton-Wahpeton	Kemnitz 21RN14	Minnesota	0	1	1
			Fort Sisseton	South Dakota	0	1	1
			Unnamed	North Dakota	0	1	1
				Total Sisseton-Wahpeton	**0**	**3**	**3**
	Chiwere	Winnebago	Fort Randall (near)	South Dakota	1	0	1
			Blue River	Wisconsin	1	1	2
				Total Winnebago	**2**	**1**	**3**
	"Siouan"	"Siouan"	Cooper Village	21ML16	1	0	1
			Fort Randall	North Dakota	1	0	1
			Fort Sully	North Dakota	0	3	3
			Big Bend	39BF - -	1	0	1
			Sitting Crow	39BF225	1	1	2
			Buchannon Moundd	39RO03	1	2	3
			Daugherty Mound	39RO10	0	2	2

Table 3-3 (continued).

Language Family	Dialect	Tribal/Band	Site	Site Number or State	Sample Size Male	Female	Total
Central Siouan	"Siouan"	"Siouan"	Centerville	39CL - -	1	0	1
			Unnamed	39CL1C	2	0	2
			Kaltasulas	39CL1B	1	0	1
			Unnamed	39ST-----	1	0	1
			Unnamed	Mutter Museum	1	0	1
			Unknown	Smithsonian	2	0	2
			Unknown	Peabody Museum	2	0	2
				Total Unknown Siouan	**15**	**8**	**23**
	TOTAL SIOUAN SAMPLE SIZE				***41***	***32***	***73***
Algonquian		Cheyenne	Fort Pembina	North Dakota	1	0	1
			Pembina	North Dakota	2	0	2
			- - -	North Dakota	0	1	1
			Fort Robinson	North Dakota	13	5	18
				Total Cheyenne	**16**	**6**	**22**
		Cree	Moose Factory Island	Manitoba	0	1	1
				Total Cree	**0**	**1**	**1**
		Ojibwa	Kathio Schl. Vill.	21ML07	1	2	3
			Petaga Point	21ML11	0	1	1
			Red River Area	Manitoba	0	1	1
			Winnipeg River	Manitoba	1	0	1
			Fort Brady	Michigan	6	1	7

Table 3-3 (continued).

Language Family	Dialect	Tribal/Band	Site	Site Number or State	Sample Size Male	Female	Total
Algonquian		Ojibwa	Fort Pembina	North Dakota	1	0	1
			Pembina	North Dakota	2	0	2
				Total Ojibwa	**11**	**5**	**16**
		TOTAL ALGONQUIAN SAMPLE SIZE			***27***	***12***	***39***
TOTAL HISTORIC SAMPLE					**68**	**44**	**112**

Hamline University Osteology Laboratory in preparation for repatriation and reburial as mandadted by NAGPRA and the Minnesota Human Remains and Reburial Project.

Data Class and Variable Selection

The usefulness of these data categories for biodistance studies is well documented (Glenn 1974; Hanihara 1997; Hemphill 1998,1999; Howells 1966, 1973; Irish 1993; Ishida and Dodo 1997; Jantz 1973, 1977,1994; Jantz and Owsley 1994; Jantz et al. 1981; Konigsberg 1987; Lukacs and Hemphill 1991; Nelson 1998; Ossenberg 1974; Pfeiffer 1977; Powell 1995; Scherer 1998; Scott and Turner 1997; Turner 1985, 1987, 1993; Wilkinson 1971). A number of researchers have sought to determine which class of data provides the most accurate assessment of population relationships or argued that one class is more biologically meaningful (Buikstra 1976; Droessler 1981; Ossenberg 1969, 1974; Rightmire 1976; Scott and Turner 1997). No clear winner has emerged, however, offering a no-fault route to the accurate reconstruction of ancient population relationships. Konigsberg (1987:88-89) efficiently summarizes the state of affairs, "In contrast to earlier claims that either metric or non-metric traits were better indicators of the genome or of phylogenetic history, recent work has indicated that the two classes of traits are closely interrelated" (see Cheverud et al. 1979; Corruccini 1976). Given the interrelationship between metrics and non-metrics, it would be difficult to argue that one group of traits is biologically more informative. Furthermore, in terms of genomic information, neither set of traits appears to have higher heritabilities among the one human population so far studied for a number of traits (Sjøvold 1984).

Cranial metrics were selected as the focus of the current research for a number of reasons. First, a number of heritability studies have demonstrated statistically significant

heritability estimates for various anthropometric characters (Clark 1956; Nakata et al. 1974; Osborne and DeGeorge 1959; Susanne 1977) indicating a significant genetic component in their expression. Secondly, preliminary assessment of availability of crania for biodistance analysis indicated crania were, in fact, present from a majority of archaeological phases and time periods in Minnesota, as well as from surrounding regions. Additionally, crania of relevant phases are not typically affected by artificial deformation and other cultural practices that compromise the completeness of the skulls did not appear to significantly affect many phases. Also important is that a number of biodistance studies conducted in regions bordering the current study area are based on craniometric data and provide an opportunity to compare results and extend geographically the areas which provide some information on the biological relationships between local groups. Biodistance studies based on dental metric and cranial nonmetric traits are not as prevalent in the study area or surrounding regions (for two notable exceptions see Ossenberg (1974) and Scherer (1998)). Finally there are a wide range of cranial measurements to choose from in order to best identify the combination of measurements that best discriminate between populations (Howells 1973; Martin 1956-57; Moore-Jansen and Jantz 1986). In summary, the selection of cranial metric traits as the basis for the current biodistance study is sound based on reasonable heritability estimates, availability of crania, and the existence of comparative studies.

Variable Set

The selection of measurements, or variables, forms a very important basis for any biodistance analysis. Factors to consider when compiling the final list of measurements to take include known heritability estimates (see Osborne and DeGeorge 1959),

representation of broad functional complexes of the human skull (Baer and Harris 1969), replicability of measurement, frequently missing data points relative to the sample under consideration, redundancy of measurements, and measurements the researcher believes may reflect differences between samples based on observation of morphological differences. The initial list of variables collected on each skull are listed in Table 3-4. Consideration of the above factors resulted in the reduction of the initial variable set of 84 to final variable set of 41 measurements (Table 3-5).

The variable set utilized here is comprised of measurements defined by many researchers. A majority of the measurements are defined in Howells (1973:159 - 190). The remaining variables are defined in Bass (1987), Boyd (1988), Key (1983), and Moore-Jansen and Jantz (1986). Howells (1973) assigned a three letter code for each measurement; his codes are utilized here with some modification. Key (1983:140) continued this practice and assigned a three letter code to the new variables he defined. The variables defined in Bass (1987), Boyd (1988), and Moore-Jansen and Jantz (1986) were assigned a three letter code by the author.

All crania from Minnesota, Manitoba, Ontario, as well as the historic Assiniboine, Cree, Mdewakanton, Oglala, Ojibwa, Sisseton-Wahpeton, Winnebago, and some of the Santee and Cheyenne were measured by the author (n = 172; 66%). Cranial measurements for the remainder of the sample (n = 134; 44%) were taken by Key (1973) and Jantz (personal communication). Dr. Patrick Key generously provided cranial data from the Sonota, Great Oasis, Mill Creek, the Oneota from Iowa, the South Dakota Arvilla, and the North Dakota Devils Lake-Sourisford. Dr. Richard Jantz provided data from the Teton, Yankton, and all but one of the Cheyenne. Due to time limitations an

Table 3-4. Initial Variable Set.

Variable	Definition	Variable	Definition
GOL	Glabello-occipital length	SIS	Simotic subtense
XCB	Maximum cranial breadth	BPH	Basion to Porion height
NOL	Nasio-occipital length	ZMB	Bimaxillary breadth
BNL	Basion to nasion length	SSS	Bimaxillary subtense
BBH	Basion to bregma height	FMB	Bifrontal breadth
XFB	Maximum frontal breadth	NAS	Nasio-frontal subtense
WFB	Minimum frontal breadth	EKB	Biorbital breadth
FMT [NPH]	Upper facial breadth	DKS	Dacryon subtense
NGH	Total facial height	IML	Malar length, inferior
NAH	Nasion-prosthion height	XML	Malar length, maximus
ZYB	Bizygomatic breadth	MLS	Malar subtense
AUB	Biauricular breadth	WMH	Cheek height, minimum
WCB	Minimum cranial breadth	SOS	supraorbital projection
ASB	Biasterion breadth	GLS	Glabella projection
BPL	Basion to prosthion length	STB	Bistephanic breadth
NHH[NLH]	Nasal height	STS	Stephanic subtense
NLB	Nasal breadth	FRC	Frontal chord
JUB	Bijugal breadth	FRS	Frontal subtense
MAB	External alveolar breadth	FRF	Frontal fraction
MAL	External alveolar length	PAC	Parietal chord
IEE	Internal palatal breadth	PAS	Parietal subtense
IOS	Internal palatal length	PAF	Parietal fraction
MDH	Mastoid length	OCC	Occipital chord
MBD	Mastoid width	OCS	Occipital subtense
OBH	Orbital height, left	OCF	Occipital fraction
OBB	Orbital breadth, left	FOL	Foramen magnum length
DKB	Interorbital breadth	FOB	Foramen magnum breadth
NDS	Nasio-dacryal subtense	NAR	Nasion radius

Table 3-5. Final Reduced Variable Set.

Variable	Definition	Variable	Definition
WNB	Simotic chord	SSR	Subspinale radius
PRR	Prosthion radius	PBH	Porion to bregma height
DKR	Dacryon radius	PAH	Auricular height
ZOR	Zygo-orbit radius	GNI	Mandibular symphysis height
FMR	Frontomaler radius	BHT	Body height at mental foramen
EKR	Ectoconshion radius	BBR	Body breadth at mental foramen
ZMR	Zygomaxillare radius	GOG	Bigonial breadth
AVR	Molar alveolus radius	CDL	Bicondylar breadth
BRR	Bregma radius	NRB	Minimum ramus breadth
VRR	Vertex radius	IRB	Maximum ramus breadth
LAR	Lambda radius	MCS [CDW]	Mandibular condyle, sag. plane
OSR	Opisthion radius	MCT [CDL]	Mand. condyle, trans. plane
BAR	Basion radius	IRH	Maximum ramus height
MTR	Mastoid radius (angle)	MLT	Mandibular length
MTT	Mastoid radius (tip)	MAN	Mandibular angle

Table 3-5. Final Reduced Variable Set.

Variable	Definition	Variable	Definition
GOL	Glabello-occipital length	IML	Malar length, inferior
XCB	Maximum cranial breadth	XML	Malar length, maximus
BNL	Basion to nasion length	MLS	Malar subtense
BBH	Basion to bregma height	WMH	Cheek height, minimum
WFB	Minimum frontal breadth	SOS	supraorbital projection
NAH	Nasion-prosthion height	GLS	Glabella projection
ZYB	Bizygomatic breadth	FRC	Frontal chord
ASB	Biasterion breadth	FRS	Frontal subtense
BPL	Basion to prosthion length	FRF	Frontal fraction
NHH	Nasal height	PAC	Parietal chord
NLB	Nasal breadth	PAS	Parietal subtense
MAB	External alveolar breadth	PAF	Parietal fraction
MAL	External alveolar length	OCC	Occipital chord
DKB	Interorbital breadth	OCS	Occipital subtense
WNB	Simotic chord	OCF	Occipital fraction
ZMB	Bimaxillary breadth	FOB	Foramen magnum breadth
SSS	Bimaxillary subtense	EKR	Ectoconshion radius
FMB	Bifrontal breadth	LAR	Lambda radius
NAS	Nasio-frontal subtense	BAR	Basion radius
OBH	Orbital height	MBD	Mastoid Breadth
OBB	Orbital breadth		

reburial of a significant portion of the sample, a formal interobserver error study was not conducted. Informally inter-observer error was checked, however, when it was discovered that both the author, Key, and/or Jantz measured some of the same crania. If the measurement by Key and Jantz were consistently more than 5 millimeters different than the authors measurement, the variable was dropped from consideration; three variables were accordingly eliminated - bijugal breadth (JUB), minimum cranial breadth (WCB), and bistephanic breadth (STS) . The individuals with which inter-observer error was informally checked were remarkably consistent in measurement. This is not surprising, however, since Jantz trained both Key and the author in cranial measurement techniques. Unfortunately, time constraints and reburial precluded an intra-observer error study. Data were checked, however, for any outliers and, where possible, crania were re-measured in such cases.

All measurements were recorded to the nearest millimeter except the orbital measurements (OBH, OBB, DKB) and the nasal bone measurements (WNB, SIS) which were taken to the nearest tenth of a millimeter. Calipers used during measurement are the typical ones and include sliding, spreading, coordinate, and dial calipers, as well as a radiometer, head-spanner, and mandibulometer.

Univariate Descriptive Statistics

The mean and standard deviation were calculated for each measurement prior to estimating the missing variables by phase and sex using the DESCRIPTIVE STATISTICS procedure in SPSS (SPSS Inc., 1999). The results are presented in Tables 2-1 in Appendix 1.

Statistical Analysis

The widespread use of multivariate statistical methods to analyze population relationships is well documented (Buikstra et al. 1990; Key and Jantz 1990; Larsen 1997; Reyment et al. 1984; Rothhammer and Silva 1990). The application of increasingly sophisticated techniques has resulted in the formulation and refinement of an ever broadening range of research questions over the last 25 years (Bryd and Jantz 1994; Dow and Cheverud 1985; Hemphill 1999; Howells 1989; Jantz 1997; Jantz and Owsley 1994; Konigsberg 1990; Konigsberg and Buikstra 1995; Nelson 1998; Williams-Blangero 1990). An additional benefit of the extensive use of multivariate techniques has facilitated complex and sophisticated investigations in the field of quantitative genetics that have directly addressed what were once untested assumptions in biological distance analyses (Blangero 1987; Cheverud 1988; Konigsberg and Ousley 1995; Williams-Blangero and Blangero 1989) . Cheverud (1988), for example, has demonstrated that genetic- and phenotypic-correlation matrices exhibit similarity in the pattern of correlation. This is interpreted to indicate that "genetic and environmental effects on development typically produce similar patterns of phenotypic variation" (Cheverud 1988:964). Cheverud's research also highlights the necessity for a reasonably large sample sizes (minimally 40); his results indicate a strong correlation between sample size and similarity of genetic and phenotypic correlation matrices.

The application of multivariate techniques of analysis requires that certain criteria be met to ensure valid and interpretable results (Manly 1993; Rencher 1998). Most procedures cannot handle a data set with missing data points, therefore, methods of estimating missing variables have advanced alongside multivariate statistics. Secondly, *a*

priori classification of data at some level is necessary. Third, the validity of the results rests on the mathematical assumption that the data being analyzed come from a normally distributed population, and finally, that the research questions are appropriate to the specific multivariate technique applied.

The specific multivariate statistical technique applied in the present study is Direct Discriminant Function analysis (Kinnear and Gray 1995). All variables under consideration are entered in the equations at the same time in Direct Discriminant Analysis. This is in contrast to Stepwise Discriminant Analysis, another widely used type of discriminant analysis, in which variables are entered one at a time based on statistical criteria (Rencher 1998). Direct Discriminant Function Analysis was selected over stepwise due to the small sample sizes of some of the groups. Sample sizes that are smaller than the number of variables used to describe them, may result in singularity of the variance-covariance matrix, as well as a variable set of highly intercorrelated variables (Rencher 1998). Sample size may also adversely affect the reliability of the classification results (Rencher 1992b). In the situation here, it is more likely that singularity could be caused by small sample sizes since variable selection considered redundancy in the definition of the final variable set.

Discriminant function analysis is frequently applied to taxonomic questions and/or to construct functions to classify unknown individuals (Ousley and Jantz 1996). However, this statistical technique is also used to assess phenetic distances between multiple groups, determine the variables most effective in discriminating among groups, and may indirectly provide insight into the phenetic homogeneity of a specific taxonomic unit by assessing how accurately each individual's group of origin is identified (Rencher

1998:201-229; Reyment et al. 1984:42-52; SPSS Inc. 1999:243-292). The applications of direct discriminant function analysis correspond closely to the research objectives outlined previously.

Discriminant analysis commences with data sets from two or more groups. From the data linear equations are calculated that best reflect the differences between groups, or, stated more formally, "best separate the transformed mean vectors of the groups" (Rencher 1998:202). Generally, the first few discriminant functions will suffice to describe the broad group differences (Howells 1973) since the functions reflect the "uncorrelated 'dimensions' of the group differences in decreasing order of importance" (Rencher 1998:204). The remaining functions, that represent a smaller percent of variation, tend to reflect distinction between only a few groups. A discriminant function analysis produces lengthy output with many statistics, matrices, tests of significance, standardized and unstandardized discriminant function coefficients, group centroid functions, and classification results, in both summary and casewise form. Special emphasis in the current study will be given to *Canonical Discriminant Function Coefficients, the Eigenvalues and Percentage of Variance Statistics, Functions at Group Centroid,* and *Classification Results.* Discriminant function procedures were conducted using the SPSS Discriminant Function procedure of the subprogram Classify (SPSS Inc. 1999).

Data Set Preparation: Missing Data, Pooling of Sexes, and Levels of Analysis

Every multivariate statistical technique requires some 'manipulation' of the intended data set. Most of the manipulation serves to increase group and overall sample sizes. The current study is not exempt from this need. Two methods were applied in order to

maximize the sample sizes. Despite this, several archaeological phases remain under-represented or not represented at all.

Missing Data Estimation.

As noted by virtually every biological anthropologist who has ever conducted a biodistance analysis, missing data due to intentional or unintentional breakage, are not uncommon. A majority of such studies, further, cannot afford to wantonly discard every skull that yields an incomplete variable set. For this reason, various techniques have been applied to estimate the value of the missing measurement. Droessler (1981:80-85) provides a particularly thorough discussion of three commonly used techniques, substitution of group means, substitution of grand means, or prediction through multiple regression, as well as a clear explanation of here method of choice - stepwise multiple regression with pair-wise deletion. Missing data in the current study were estimated in a similar fashion to Droessler (1981:84-85). Missing data estimates were calculated from a sample of 311 individuals. Forty-nine individuals, from the larger sample of 360 individuals, were eliminated from further consideration as a result of missing more than 30% of the variable set. Nineteen measurements were entered as independent variables for the female (n = 124) subset and 20 measurements for the male (n=187) subset. Equations were calculated accordingly and missing variables were replaced with the measurement estimates prior to definition of the final variable subset and the final cranial series.

Pooling the Sexes.

Sexual dimorphism and morphological differences in shape between males and females is an important component to understanding the cultural practices of any human

population. Such differences have been used to reconstruct post-marital residence practices, marital practices, descent rules, as well as gender-based social stratification (Bentley 1991; Konigsberg 1988; Konigsberg and Buikstra 1995; Lane and Sublett 1972; Rosing 1986; Spence 1974). Nevertheless, as a result of several very small sample sizes, the sexes were pooled to increase sample sizes in the present analysis. The combining of males and females was accomplished by calculating the grand means for each sex per variable. The sex-specific grand mean was then subtracted from each individual respective of their sex. The absence of any statistically significant sex differences was verified through a MANOVA; no differences were indicated. Following this, the sexes were pooled and all analyses were conducted on the integrated sample.

Group Space and Comparative Analyses.

The final prerequisite to the statistical analysis is to define the composition of group space for the different discriminant function analyses. There are a great many group combinations that could be analyzed given the present data set, however, each would not necessarily contribute significant information in the quest to understand past population relationships. Considering the representativeness of the cranial sample, the primary questions concerning the interaction between defined archaeological cultures, and the research objectives outlined in Chapter 1, the following group combinations will be analyzed to determine population relationships:

1) **The Early Prehistoric period.** This analysis will assess the phenetic distances between the Paleoindian and Archaic groups. Of special interest in this analysis is the position of Browns Valley (21TR05) and Minnesota Woman/Pelican Rapids (21OT03) relative to each other and the remaining Archaic individuals.

2) **Paleoindian, Archaic, Woodland.** This analysis will illuminate the phenetic similarity between the earliest inhabitants of the study area and later populations,

as well as relationships between the Woodland groups. Models postulating migration and *in situ* development will be evaluated.

3) **The Late Prehistoric period.** This analysis will assess the biological relationships and phenetic similarity between Woodland, Middle Missouri/Plains Village, Oneota, and Mississippian groups. These four groups were characterized by different adaptations, were broadly contemporaneous, and varied in geographic proximity. An assessment of the degree and pattern of biological similarity will provide some insight into the interaction between these groups. Different degrees of phenetic heterogeneity may indicate differential mate exchange and existence of a social hierarchy (e.g., marriages between Ju/'hoansi (!Kung) women and Herero and Tswana men occur much more frequently than marriages between Ju/'hoansi men and Herero and Tswana women (Lee 1993)).

4) **The Late Prehistoric and Historic periods.** This analysis will be conducted to identify close relationships between the prehistoric groups and the ethnographic tribal groups identified as possibly resident in the study region in during part of the Late Prehistoric period. Of particular interest will be the comparison of the results presented here and those identified in earlier biodistance studies (Glenn 1974; Ossenberg 1974; Peterson 1963), as well as predicted by archaeologists.

5) **All Groups**. This analysis will assess the biological relationships and phenetic similarity between groups representing the 10,000 years of human occupation in Minnesota and surrounding areas. Continuity/discontinuity of cranial morphology will be identified and assessed relative to hypotheses of *in situ* evolution and migration.

CHAPTER 4

ANALYTICAL RESULTS

The primary objective of the current research is to identify the biological relationships between archaeologically defined groups in prehistoric and early historic Minnesota and surrounding areas. To achieve this end, multivariate discriminant function analysis was applied to various subsamples of the total study sample. This chapter presents the results of each level of analysis defined at the end of Chapter 3. The results of each multivariate analysis will be introduced by first providing a brief summary of the subsample analyzed and the method of analysis applied. When relevant, reference will be made to the results of a one-way analysis of variance to identify significant among- group differences for each measurement independent of all other measurements. In all but the Early Prehistoric Period analysis, the results of a multivariate discriminant function analysis follow the univariate statistics and will be evaluated to assess intergroup relationships, the cranial measurements that best discriminate between groups, and the accuracy with which group membership is predicted for each individual. Relevant output will be presented in tables and plots, including the standardized canonical discriminant function coefficients for each function, the coefficients defining the centroid for each group per function in the analysis, a scatterplot displaying the intergroup distribution along two or three discriminant functions, and predicted group membership classification results. The Early Prehistoric Period sample, due to its small sample size, is evaluated through a principal components analysis. The presentation of

results from a principal components analysis follow a similar pattern and include scatterplots of two and three principal coordinates, a table reporting the Mahalanobis Distances for each pair of individuals compared, and a table of the structure coefficients that reflect the importance of specific measurements to each component. Evaluation and discussion of the results for each biological distance comparison in light of current interpretations of archaeological contexts, sites, and materials, as well competing hypotheses and models, will be presented in Chapter 5.

The Early Prehistoric Period Series

Individuals from sites classified as Paleoindian, Archaic, and Initial/Early Woodland are included in this cranial series. Population relationships between the earliest inhabitants in the Minnesota portion of the study region will be the focus of this analysis. No Archaic or Initial/Early Woodland individuals from the remainder of the study region were included in the study sample. Although Minnesota has the distinction of having been the final resting place for two of the oldest skeletons in North America (Browns Valley, 21TR05; Pelican Rapids, 21OT03), few Paleoindian and Archaic sites have been excavated and even fewer of their burial sites. The sample size of the Early Prehistoric Period is, therefore, quite small and generally consists of individuals recovered from single, isolated, non-mound burials or small geologically formed mounds containing multiple interments. Within the larger sample of 386 individuals, a total of 19 individuals from 10 sites are identified as being from the Early Prehistoric Period. These individuals are represented by crania of varying completeness. Procedures used to estimate missing variables are not accurate for such a small sample size and for this reason a reduced variable set was constructed to represent as many complete crania as

possible. Given this restriction, the Early Prehistoric Period subsample is comprised of ten individuals from seven sites (Table 4-1). The reduced variable set consists of 18 measurements representing many dimensions of the vault and face (Table 4-2). The Paleoindian taxon consists of a single individual from the renown Brown's Valley site (21TR05). The Archaic sample consists of nine individuals from five sites, including the Early Archaic Pelican Rapids site (21OT03). The third oldest skeleton in Minnesota, Sauk Valley (21TO01) is too incomplete to include in the Early Prehistoric analysis. The Initial/Early Woodland period is represented by two sites, Voight (21WN15) and Morrison Mound (21OT02). Five of the six sites have been radiocarbon dated (Table 4-3); this number represents 31% of all chronometrically dated mortuary sites in Minnesota. The greater percentage of Early Prehistoric period mortuary sites that have been dated clearly reflects the intense interest focused on understanding the earliest inhabitants of North America, their patterns of migration, and their genetic history.

The small size of the Early Prehistoric period sample warranted the use of a different multivariate technique than that applied in the other analyses. Dr. Richard L. Jantz, University of Tennessee, Knoxville, has written a principal components program that accommodates small sample sizes and graciously offered to analyze the cranial measurements from the early prehistoric sample. This technique utilizes a pooled within-groups covariance matrix from the larger Howells craniometric data base (Howells 1989). Pooling of males and females was accomplished by centering each individual on the sex-specific means of each variable. The covariance matrix is then calculated from this pooled sample. Principal components were subsequently extracted from the larger pooled within-groups covariance matrix. Mahalanobis distances (D^2) were estimated

Table 4-1. Cranial Sample for the Early Prehistoric Period Principal Components Analysis.

Site Name	Site Number	Sex	Archaeological Context
Browns Valley	21TR05	M	Paleoindian
Pelican Rapids	21OT03	F	Prairie Archaic
Rooney Mound	21PO13	M	Prairie Archaic
Clitherall	21OT78	M	Prairie Archaic
Helget Burial	21BW82	M	Prairie Archaic
Voight	21WN15A	F	Eastern Archaic/Initial Woodland
	21WN12B	M	
Morrison Mound	21OT02A	F	Prairie Archaic/Initial Woodland
	21OT02B	F	
	21OT02C	M	

Table 4-2. Reduced Variable Set for the Early Prehistoric Period Principal Components Analysis.

Variable (Code)	Variable (Code)
Maximum Cranial Length (GOL)	Parietal Chord (PAC)
Maximum Cranial Breadth (XCB)	Parietal Subtense (PAS)
Biasterion Breadth (ASB)	Parietal Fraction (PAF)
Nasal Height (NHH)	Nasion Radius (NAR)
Nasal Breadth (NLB)	Zygo-orbitale Radius (ZOR)
Orbit Height (OBH)	Frontomalare Radius (FMR)
Orbit Breadth (OBB)	Ectoconshion Radius (EKR)
Frontal Subtense (FRS)	Zygomaxillare Radius (ZMR)
Frontal Fraction (FRC)	Vertex Radius (VRR)

Table 4-3. Radiocarbon Dates for Early Prehistoric Period Sites.

Site (Number)	Sample	Material	RCBYP	Reference
Browns Valley (21TR05)	NZA-1102	Human Bone	8790 ± 110	Shane 1991
	NZA-1808	Human Bone	9049 ± 82	Shane 1991
Pelican Rapids (21OT03)	CAMS-6380	Human Bone	7840 ± 70	O'Connell and Myster 1996
Rooney Mound (21PO13)	?	Human Bone	~ 4000	Myster and O'Connell 1997
Morrison Mound (21OT02)	I-787	Charred Wood	2640 ± 200	Johnson 1964
Voight (21WN15)		Human Bone	2557 ± 52	Myster and O'Connell 1997

from this covariance matrix. Principal component scores were calculated by converting them to Z-scores and multiplying by the coefficient matrix of the factor scores. Following this procedure, each principal component has a mean of zero and a standard deviation of one, respectively.

Principal components analysis results in the reduction of a large variable set into a smaller number of uncorrelated components that reflect, in decreasing percentages, the maximum variance (Rencher 1998; Reyment et al. 1984). In the current study these components provide insight into the contribution of variable combinations to the separation of those individuals identified as living during the Early Prehistoric period. Mahalanobis distances (D^2) were estimated for all pairs of groups from the pooled covariance matrix. Principal coordinates were subsequently extracted from the D^2 matrix and define intergroup variation along orthogonal axes. Structure coefficients are

calculated by determining the correlation between the principal coordinates and the original variables. Intergroup relationships can be effectively illustrated in two- or three-dimensional scatterplots defined by the distribution of structure coefficients along the two to three axes that account for the most between-group variation.

It should be stated that the results presented here are to be cautiously interpreted. Such a small sample size could easily reflect sampling error rather than true biological variation. Assessment of the results relative to archaeological data may determine the degree to which the biological distances are due to sampling error or are, in fact, an accurate reflection of intergroup relationships during this time in Minnesota.

Intergroup Relationships

The principal components analysis resulted in the definition of nine principal coordinates that account for 100% of the variation between individuals. The first two principal coordinates account for 49.24% of the intergroup variation (Table 4-4). Figure 4-1 represents the distances between the Early Prehistoric Period sites displayed along two axes representing the first (30%) and second (19 %) principal coordinates. Viewing the plot there appears to be no clear pattern of relationships; no temporal or geographical trends are evident. The two sites represented by multiple individuals exhibit no cohesion; the individuals from each site are widely separated. Browns Valley (21TR05) and Pelican Rapids (21OT03), the two oldest individuals, do form a loose cluster in the center of the plot. Considering each component separately, some patterns emerge. Principal Coordinate 1 (PC1) basically distinguishes the individuals from the Morrison Mounds site (21OT02); this may be a temporal phenomenon since Morrison Mound is the only mound site in this group and is probably Woodland. Browns Valley, Pelican

Table 4-4. Principal Coordinates, Eigenvalues, and Percentage of Variation Represented: Early Prehistoric Period Series.

Site	PC 1	PC 2	PC 3
Browns Valley (21TR05)	-0.3520	-0.1292	-4.1130
Pelican Rapids (21OT03)	-0.6523	-2.3282	1.7330
Rooney Mound (21PO13)	0.1979	3.3390	1.7161
Clitherall (21OT78)	-3.1477	0.1419	0.8591
Helget Burials (21BW82)	1.0445	2.0015	-2.8962
Morrison Mound			
(21OT02) - A	2.9510	0.0829	0.4427
- B	4.5914	-3.6642	0.4423
-C-1	1.6710	1.8119	0.6769
Voight			
(21WN15) -A	-1.5223	1.1287	1.8565
- B	-4.7814	-2.3844	-0.7174
Eigenvalue	69.3482	44.2876	36.8023
% Variation	30.05	19.19	15.95

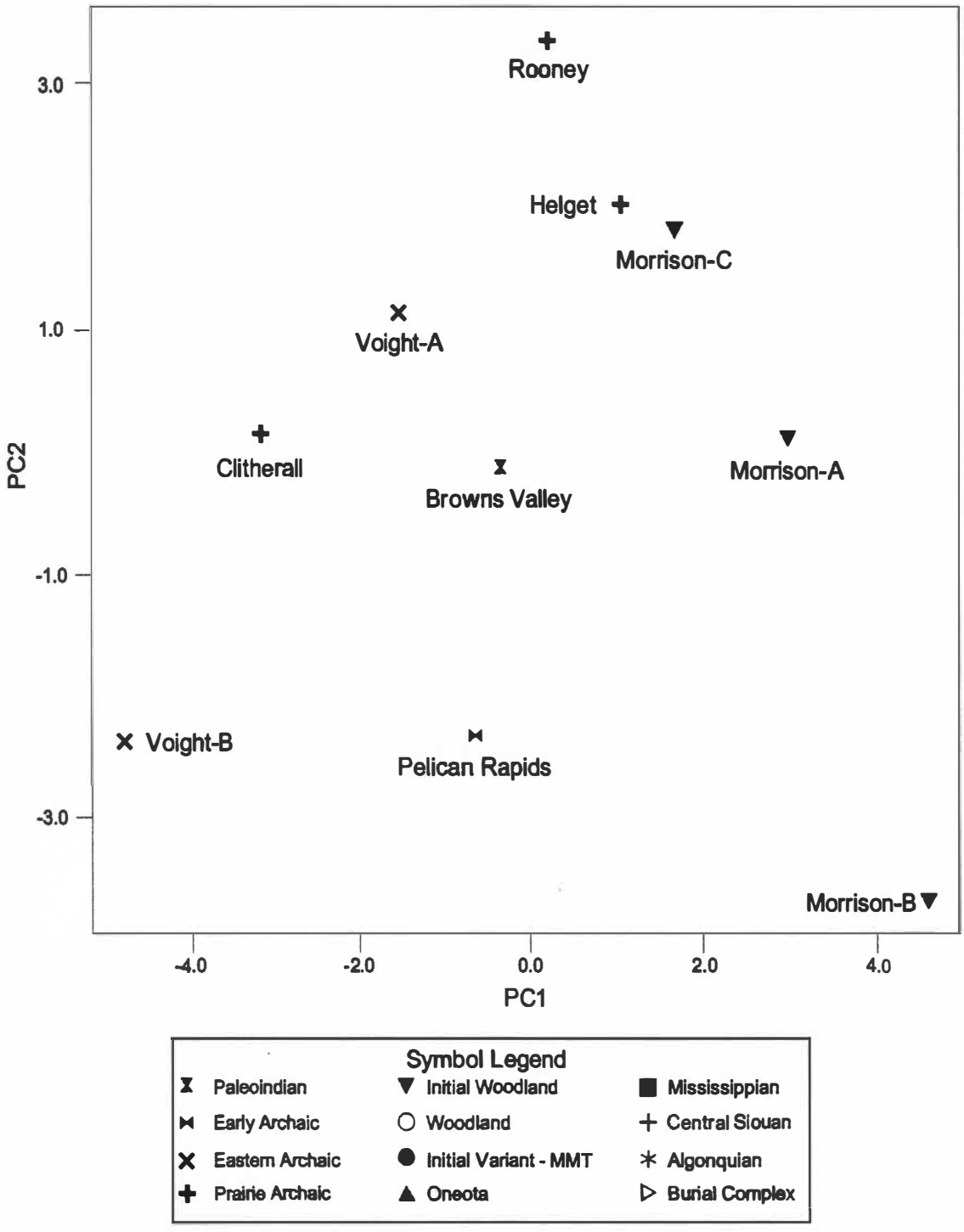


Figure 4-1. Scatterplot of Group Centroids Along Principal Components 1 and 2: Early Prehistoric Series.

Rapids, and Rooney Mound (21PO13) form a tight cluster in the center. To the left is a loose group of three individuals, two from the Voight site (21WN15) located in extreme southeastern Minnesota. Voight is the sole representative of the Eastern Archaic tradition and this may partly reflect this distinction though the Prairie Archaic site of Clitherall (21OT78) is between them. Site distribution along Principal Coordinate 2 (PC 2) exhibits no obvious patterning. Individuals belonging to the same site are generally quite distant from one another. The two oldest sites are separated but not significantly so (see below). A tight cluster of three individuals is observable, however, along the lower quarter of the PC 2. This cluster is comprised of Pelican Rapids, Voight Individual B, and Morrison Individual B. The addition of PC 3 increases the percent of intergroup variation represented to 65.1% and functions to separate Browns Valley from the rest of the early prehistoric sample; the closest individual to Browns Valley is the male individual from the Helget (21BW82) site (Figure 4-2).

In summary, there is no clear temporal pattern illustrated by the groups distribution; the two most recent sites, Voight (21WN15) and Morrison Mound (21OT02) are located on either side of the zero point and the two oldest in the center of the plot. Distance due to membership in an archaeological tradition does not seem to be a factor either since one individual of the more eastern Voight site is situated near to both the Paleoindian and Prairie Archaic groups. Finally, the two sites with multiple individuals exhibit little site cohesion; the Voight individuals are displaced along both axes and the Morrison Mound individuals separate only along PC 2.

The genetic affinities of the oldest skeletons in North America has been a point of contention for some time. Figure 4-3 illustrates the position of the members from the

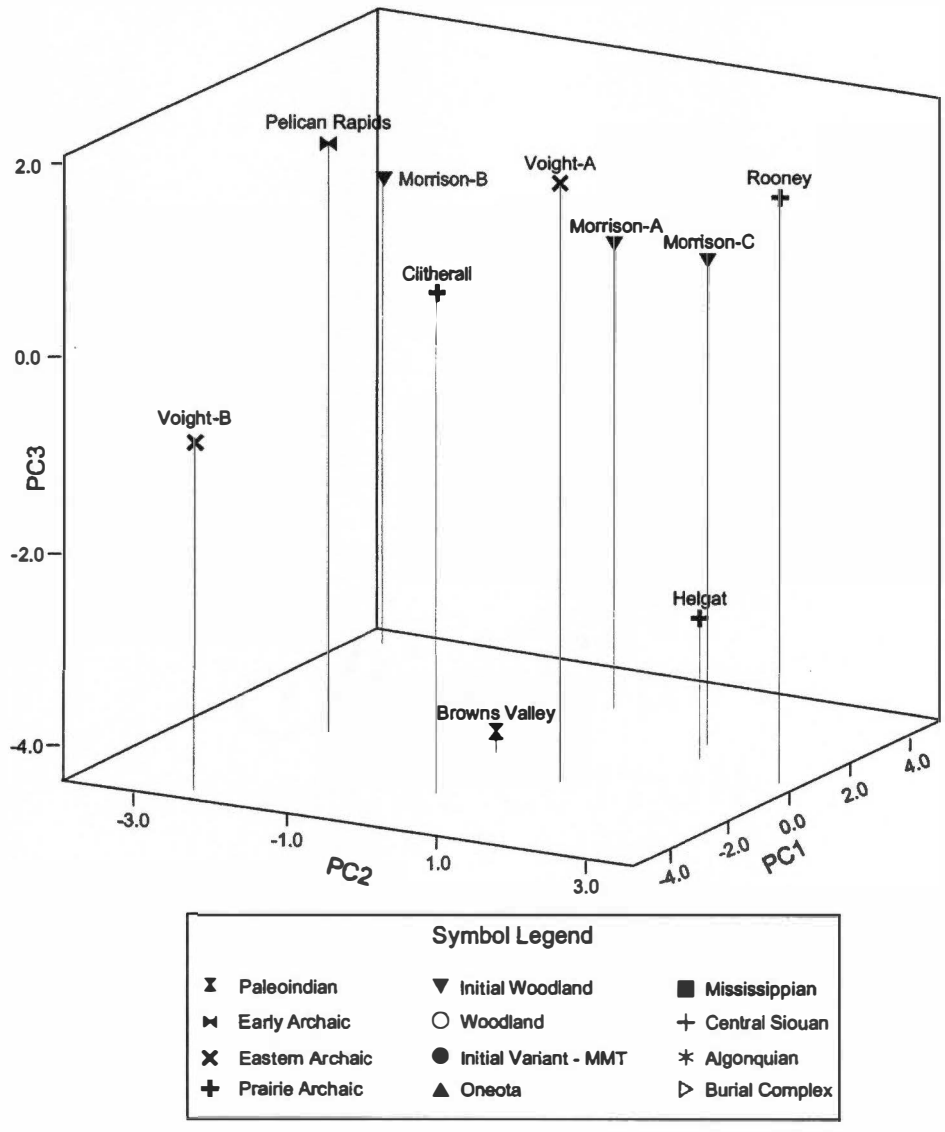


Figure 4-2. Scatterplot of Group Centroids Along Principal Components 1, 2, and 3: Early Prehistoric Series.

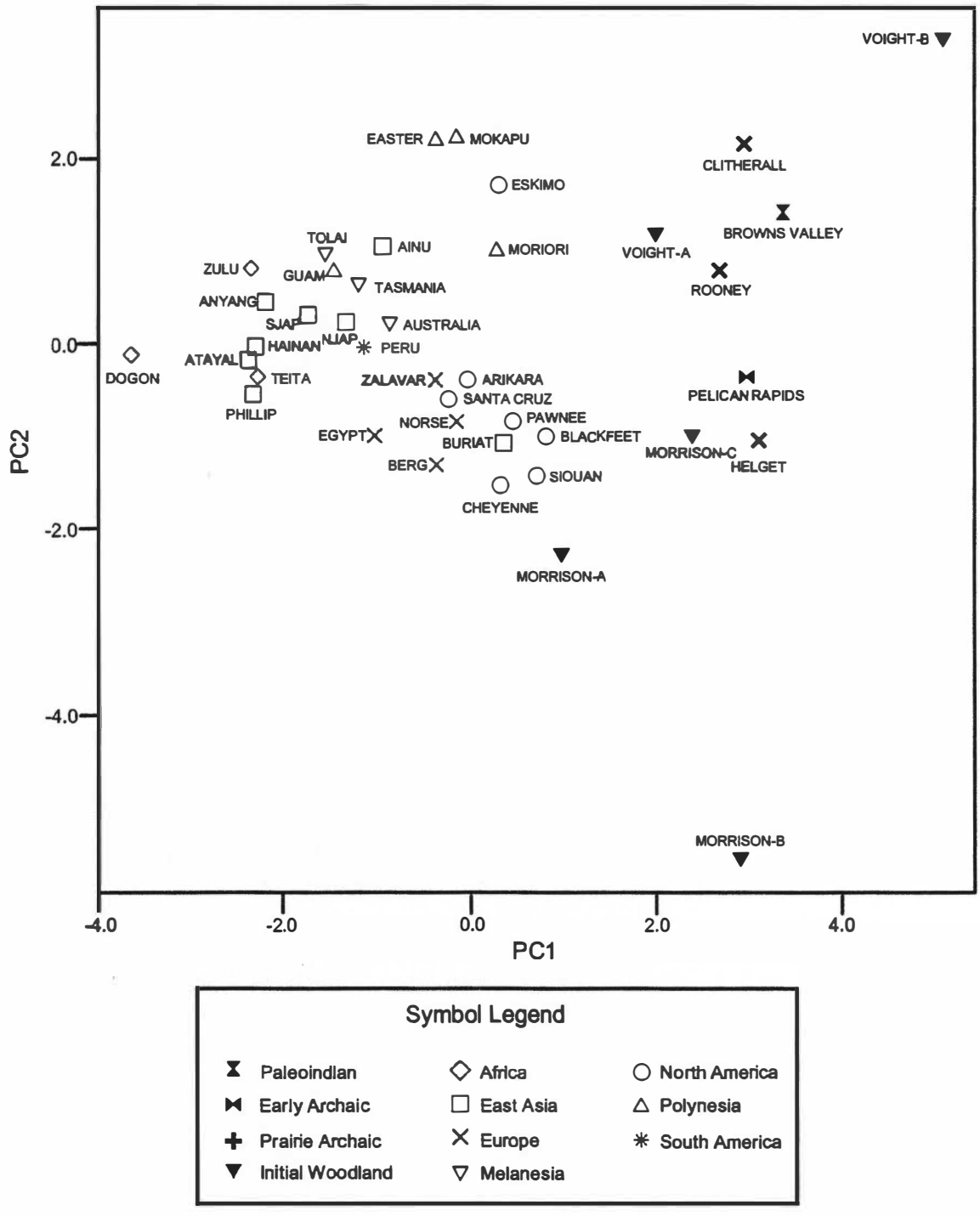


Figure 4-3. Scatterplot of Group Centroids Along PC 1 and 2: Minnesota Series and World Sample.

Early Prehistoric sample relative to a sample of widely distributed world populations from Africa, Europe, North America, South America, Australia, Asia, and Polynesian Islands. Principal coordinates are plotted along PC1 and PC2 which together account for 41.25% of intergroup variation. It is beyond the scope of this dissertation to fully evaluate the population distances exhibited by this world-wide sample, however, it is noteworthy that seven of the10 Minnesota individuals, including Browns Valley and Pelican Rapids, form a cluster quite distinct from the other groups. A more loosely defined cluster adds Morrison Individual A, the Inuit group, and three Pacific Ocean groups to the Minnesota cluster.

Mahalanobis Distances

Table 4-5 presents the Mahalanobis distances for each group comparison. Those values indicated by an "*" indicate statistical significance at the 0.05 level. A perusal of the values indicates that two individuals are significantly distinct in their morphology. First, Morrison Individual B (21OT02) is significantly distant from seven of nine individuals. Secondly, Voight Individual B (21WN15) is significantly displaced from five of nine individuals. The eight remaining individuals are significantly distant from between one to three individuals. The Mahalanobis distance estimates generally mirror the overall distances illustrated in Figure 4-1; few are statistically significant.

Significant Variable Combinations

One of the benefits of a principal components analysis is the identification of combinations (components) of variables from the larger variable set that most effectively represent intergroup variation. The magnitude of the variables that comprise a principal component are important in characterizing or defining that component. A positive or

Table 4-5. Mahalanobis Distance Estimates for Early Prehistoric Period Comparisons Based on 18 Variables.

Individual	21OT02A	21OT02B	21OT03	21WN15A	21BW82	21OT02C	21OT78	21PO13	21TR05	21WN15B
21OT02A	0.0000									
21OT02B	5.9062	0.0000								
21OT03	6.3434	7.3598	0.0000							
21WN15A	5.9851	8.6116*	5.3327	0.0000						
21BW82	6.4552	8.1190*	8.1694*	6.6913	0.0000					
21OT02C	6.1507	7.6028*	6.6808	6.3053	6.9833	0.0000				
21OT78	7.1834	8.8910*	6.4184	4.1082	6.8230	7.1648	0.0000			
21PO13	6.0264	8.8795*	7.0262	5.4404	6.9020	5.3659	6.3435	0.0000		
21TR05	6.8556	8.7863*	7.0444	7.2902	6.8140	6.9207	7.5021	7.6289*	0.0000	
21WN15B	8.9719*	9.7850*	6.4972	6.8596	8.5322*	8.6600*	4.7940	8.3245*	7.3055	0.0000

Note: (*) indicates statistically significant distances

negative loading indicates the expression of the measurement. Principal components have been interpreted as indicative of morphological complexes (e.g., Howells 1973; Key 1983). Important to this concept is the evaluation of a large number of variables in order to assess a wide variety of combinations of measurements to most effectively represent the variation between groups. Due to the overall fragmentary condition of the crania dated to the Early Prehistoric Period, only 18 variables of the original set (85 measurements) described the cranial morphology of each individual (Table 4-2). The combination of variables most effective in separating the groups under consideration and the differential weights assigned to them will be discussed below.

The structure coefficients for the first two principal components are presented in Table 4-6. These coefficients reflect the relative weight of the variable to the definition of each component. The first principal component accounts for 30.05% of among-group variance. The most heavily weighted variables are orbital breadth (OBB), frontal subtense (FRS), maximum length (GOL), parietal chord (PAC), maximum breadth (XCB) and vertex radius (VRR). These variables are related to total length, breadth, and height of the skull. The second discriminant function explains 19.19% of among- group variation and reflects, generally, differences in facial projection and cranial breadth. Those individuals situated along the negative axis of PC I are characterized by short, narrow and low skulls.

Paleoindian, Archaic, and Woodland Series

Individuals from sites classified as Paleoindian, Archaic, and Woodland are included in this analysis. Determination of the biological distance between the earlier Paleoindian and Archaic groups and the later Woodland populations will provide insight into the

Table 4-6. Among Canonical Structure Coefficients: Early Prehistoric Period Series.

Canonical Structure Coefficient	Highest Variable Loading			
1	OBB	-0.844	XCB	-0.571
	FRS	-0.686	OBH	-0.319
	GOL	-0.652	NLB	0.310
	VRR	-0.640	ZOR	0.294
	PAF	0.628	NHH	0.278
	PAC	-0.609	ASB	0.277
2	NLB	0.817	NHH	0.346
	VRR	-0.650	ASB	0.326
	ZMR	0.548	OBH	-0.316
	ZOR	0.547	FMR	0.314
	PAF	-0.376	XCB	0.302
	GOL	0.341	FRF	0.239

nature of the transition from the Archaic to the Woodland period and the trend of increasing regionalization. The sample size for the skeletal series considered here is much larger than the preceding analysis. Archaeological sites from seven states and two Canadian provinces yielded 149 measurable crania (see Table 3-2). The variable set is expanded from that applied to the Early Prehistoric Period analysis due to the more complete crania of the Woodland individuals and consists of 41 measurements (see Table 3-5). This measurement set will be utilized for the remainder of all intergroup analyses. The means of each measurement by phase and sex are reported in Appendix 1. The

Paleoindian-Archaic sample was reduced to nine individuals from six sites from the sample (n=10) utilized in the previous analysis. The crania are from a different subset of Archaic sites and reflect the most complete skulls of the total Archaic sample and the late inclusion of the Helget burial (21BW82). Inclusion of Helget in the Paleoindian, Archaic, and Woodland sample would have necessitated a recalculation of missing variables. Re-analysis so late into the project was not possible due to time constraints and precluded the inclusion the Helget male. Missing data were estimated as described in Chapter 3. The four individuals from Morrison Mound (21OT02) were reassigned to the unclassified Woodland (WD) category as a result of the distinct (from that characterizing the Archaic) mortuary burial pattern recorded for the site (Wilford et al. 1969 and see Chapter 2) and displacement from the Archaic and Paleoindian individuals in the results from the Principal Components analysis (see Figure 4-1).

The discriminant function analysis resulted in the definition of 13 canonical discriminant functions that accounted for 100% of the variation between groups. A chi-square transformation of Wilks' Lambda indicates that the group centroids for the first two discriminant functions are significant at the 0.05 level of probability and thus reflect significant among-group differences. Considered together functions 1 and 2 account for 35.1% of the intergroup variation. Figure 4-4 illustrates the biological distance between the Woodland, Archaic, and Paleoindian groups as defined by the first and second discriminant functions.

Predictor Variable Set

Table 4-7 presents the results of a one-way analysis of variance by variable for the male-female pooled sample. Statistically significant *F* ratios were obtained for 11 of 41

variables (26.8%). Three of the nine statistically significant measurements, minimum frontal breadth (WFB), simotic chord (WNB), and bimaxillary breadth (ZMB), contribute to the morphology of the anterior vault and aspects of upper facial breadth. Two other measurements, occipital chord (OCC) and the radius to lambda from the from the transmeatal plane (LAR) describe the morphology of the occipital bone. The variables that describe occipital morphology suggest that the shape of this bone differs significantly between groups. A review of the group means (Appendix 1) indicates that these measurements reflect the longer, more narrow vaults and a more rounded, prominent lambda observed for the Browns Valley (21TR01) Paleoindian and Archaic individuals. Significant differences for the above mentioned measurements indicate this morphology is not shared by the later Woodland groups.

The standardized discriminant function coefficients for the first two functions are presented in Table 4-8. The standardized coefficients reflect the relative weight of the variable to the definition of each canonical variate (discriminant function) and, consequently their contribution to the discrimination between groups. The first discriminant function accounts for 21.4% of the total between-group variance. The most heavily weighted variables are minimum frontal breadth (WFB), occipital chord (OCC), cheek height (WMH), ectoconshion radius (EKR), interorbital breadth (DKB), frontal fraction (FRF), maximum breadth (XCB), zygomatic breadth (ZYB), frontal chord (FRC), mastoid breadth (MBD), and radius to lambda (LAR). Four of the nine variables that are statistically significant in the univariate analysis are represented in the highest loadings on DF I. The additional variables that contribute most significantly to the first discriminant function represent other vault length measurements and different aspects of

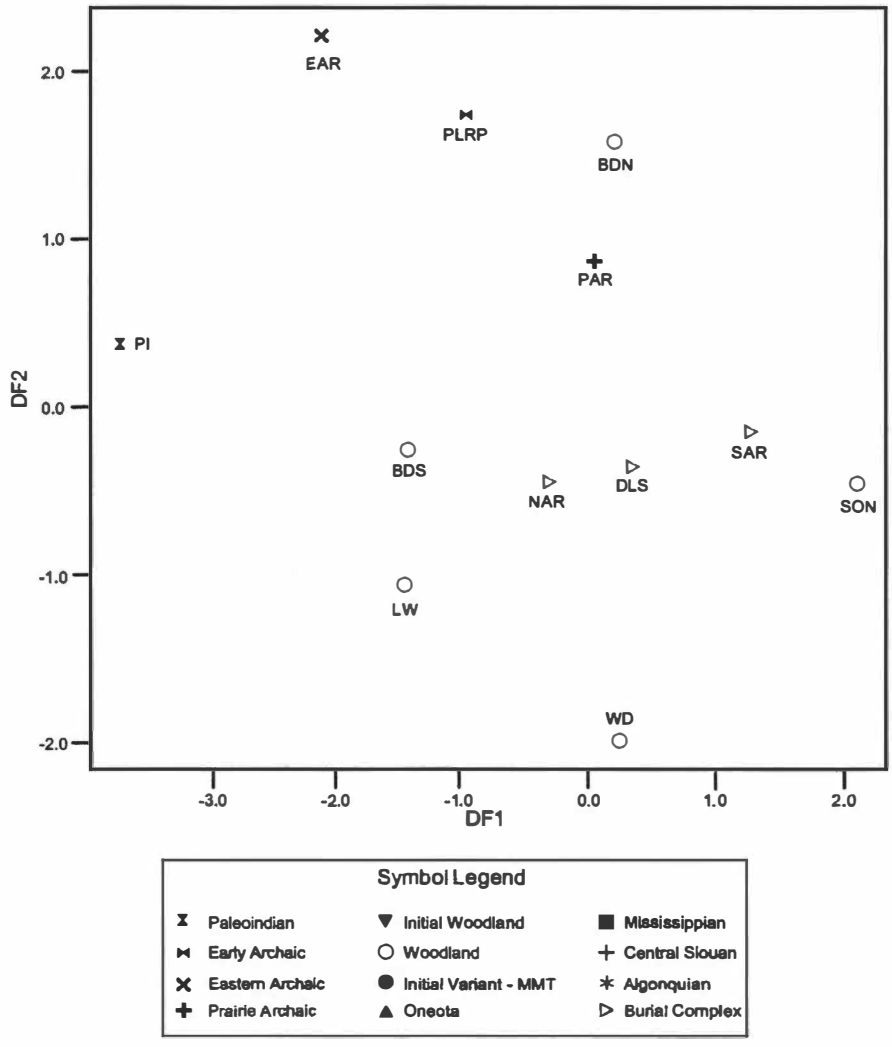


Figure 4-4. Scatterplot of Group Centroids Along Discriminant Functions 1 and 2: Paleoindian, Archaic, and Woodland Series.

Table 4-7. Results of an Analysis of Variance of Group Means per Variable: Paleoindian, Archaic, and Woodland Series.

Measurement	F-value	Significance
Max. Cranial L. (GOL)	1.120	.351
Max. Cranial B. (XCB)	2.071	.026*
Basion-Nasion L.(BNL)	1.078	.383
Basion-Bregma L. (BBH)	2.058	.027*
Min. Frontal B.(WFB)	2.725	.003*
Upper Facial H. (NAH)	1.121	.349
Bizygomatic B.(ZYB)	1.171	.313
Biasterion B.(ASB)	2.106	.024*
Basion-prosthion L.(BPL)	1.997	.033*
Nasal H. (NHH)	1.340	.209
Nasal B. (NLB)	1.022	.430
Ext. Palatal B. (MAB)	1.195	.296
Ext. Palatal L. (MAL)	1.750	.069
Mastoid B. (MBD)	2.674	.004*
Orbit H. (OBH)	1.728	.073
Orbit B. (OBB)	1.614	.101
Interorbital B. (DKB)	1.582	.111
Simotic Chord (WNB)	2.431	.008*
Bimaxillary B. (ZMB)	1.710	.077
Zygomaxillary S. (SSS)	2.010	.032*
Bifrontal B. (FMB)	1.811	.058
Nasio-frontal S.(NAS)	0.376	.963

Table 4-7 (continued).

Measurement	F-value	Significance
Inferior Malar L. (IML)	1.373	.192
Max. Malar L. (XML)	3.204	.001*
Malar S. (MLS)	0.899	.543
Min. Cheek H. (WMH)	1.456	.155
Supraorbital Proj. (SOS)	1.804	.059
Glabella Proj. (GLS)	1.573	.113
Frontal Chord (FRC)	1.681	.084
Frontal S. (FRS)	0.398	.955
Frontal Fraction (FRF)	1.100	.366
Parietal Chord (PAC)	0.992	.457
Parietal S. (PAS)	0.981	.466
Parietal Fraction (PAF)	0.902	.540
Occipital Chord (OCC)	2.265	.014*
Occipital S. (OCS)	1.411	.175
Occipital Fraction (OCF)	1.218	.281
For. Mag. B. (FOB)	1.109	.359
Ectoconshion R. (EKR)	1.454	.156
Lambda R. (LAR)	3.341	.000*
Basion R. (BAR)	1.805	.059

Note: df1 = 11, df2 = 137
* Significant at the 0.05 probability level

Table 4-8. Standardized Discriminant Function Coefficients: Paleoindian, Archaic, and Woodland Series.

Discriminant Function	Highest Variable Loading			
1	XML	-0.922	MLS	0.474
	OCC	-0.696	WMH	0.468
	BPL	-0.629	IML	0.464
	LAR	0.606	EKR	0.410
	MBD	0.527	XCB	-0.402
	WFB	0.491	FMB	-0.376
2	BPL	-0.546	BNL	0.409
	ZMB	0.501	XCB	-0.394
	FRF	0.448	BBH	-0.375
	IML	0.414	FRS	0.370
	BAR	0.414	OBB	-0.310
	WNB	-0.412	FRC	-0.302

DF 1: 21.4% Variation Represented
DF 2: 15.8% Variation Represented

facial breadth. The second discriminant function represents 15.9% of the total between group variance. The most heavily weighted variables are parietal sublease (PAS), maximum malar length (XL), foramen magnum breadth (FOB), malar sublease (MLS), frontal fraction (FRF), frontal chord (FRC), bimaxillary breadth (ZMB), frontal sublease (FRS), minimum frontal breadth (WFB), radius to lambda (LAR), parietal fraction (PAF), maximum cranial breadth (XCB), and bizygomatic breadth (ZYB). Five of the nine variables that are statistically significant in the univariate context represented in the highest loading on function two. Additional variables important in the definition of the second discriminant function relate primarily to frontal and malar morphology.

Biological Distance

Table 4-9 reports the function coefficients at the centroid of each group and Figure 4-4 illustrates the intergroup relationships defined by the first two canonical variates. Consideration of the centroids associated with the first discriminant function reveals two loose groups. One group reflects an association between the Late Woodland sample, Pelican Ripids (21OT03), the Eastern Archaic, Browns Valley (21TR05), and Voight (21WN15) and the second comprised of the Woodland group situated on the prairie region of the study area, including the Prairie Archaic group. Also included in this cluster are the Late Woodland (LW), Woodland (WD), and North Blackduck group. The second discriminant function clearly illustrates a temporal arrangement of the groups. Those groups with the most positive centroids are the Paleoindian and Archaic sites (except Clitherall, 21OT78). The unclassified Woodland group (WD) is displaced from the tight cluster of the Woodland and probably reflects the variability of this group. Considered together there appears to be three primary clusters defined taxonomically by

Table 4-9. Group Centroids in Reduced Space: Paleoindian, Archaic, and Woodland Series.

Group	Discriminant Function 1	Discriminant Function 2
Paleoindian (PI)	-3.743	0.376
Pelican Rapids (PLRP)	-0.952	1.738
Prairie Archaic (PAR)	0.0563	0.872
Eastern Archaic (EAR)	-2.104	2.211
Woodland (WD)	0.251	-1.990
Late Woodland (LW)	-1.445	-1.060
Sonota (SON)	2.099	-0.463
North Arvilla (NAR)	-0.281	-0.442
South Arvilla (SAR)	1.277	-0.150
Devils Lake-Sourisford (DLS)	0.351	-0.354
North Blackduck (BDN)	0.217	1.577
South Blackduck (BDS)	-1.421	-0.252
Percent Variation Represented	21.4%	15.8%

Total Variation Represented: 37.2%

tradition. The anomaly is the association of the Late Woodland North Blackduck sample with the Archaic groups. The North Blackduck sample remains an outlier to the other Woodland groups in most analyses. The Archaic cluster is loosely associated and the significant distance between the Eastern Archaic and Prairie Archaic samples (with the addition of the Woodland groups) likely reflects the cultural and temporal differences that characterize these two traditions (Anfinson 1987).

Group Classification

Table 4-10 summarizes the accuracy of group membership predictions for the Paleoindian, Archaic, and Woodland cranial series. Accuracy of group membership predictions for the total number of individuals is 77.2%. This means that 115 of 149 individuals were classified into the correct group. This reasonably high classification rate suggests that there are, in fact, distinctive patterns of cranial morphology that characterize a majority of the groups. It should be noted that four groups are represented by small sample sizes: Browns Valley (n = 1), Pelican Rapids (n = 1), Prairie Archaic (n = 3), and Eastern Archaic (n = 4). Not surprisingly, every individual in these groups was correctly identified as belonging to their group of origin. The more northern Arvilla sites had the poorest classification percentage (52.6%), followed by Devils Lake-Sourisford (63.2%), the southern cluster of Arvilla (76%), and the northern Blackduck sites (77.8%). When misclassified, individuals are most likely to be classified with the Devils Lake-Sourisford group (9/34), followed by North Arvilla (6/34). The meaning of this pattern of misclassification will be discussed in Chapter 5.

Table 4-10. Accuracy of Group Membership Predictions: Paleoindian, Archaic, and Woodland Series.

Actual Group	PI	PLRP	PAR	EAR	WD	SON	LW	BDN	BDS	NAR	SAR	DLS
Paleoindian (PI)	1	0	0	0	0	0	0	0	0	0	0	0
Pelican Rapids (PLRP)	0	1	0	0	0	0	0	0	0	0	0	0
Prairie Archaic (PAR)	0	0	3	0	0	0	0	0	0	0	0	0
Eastern Archaic (EAR)	0	0	0	4	0	0	0	0	0	0	0	0
Woodland (WD)	0	0	0	0	6	0	0	0	0	0	0	0
Sonota (SON)	0	0	0	0	0	8	0	0	0	0	0	1
Late Woodland (LW)	0	0	0	0	0	0	14	0	0	0	1	0
North Blackduck (BDN)	0	0	0	0	0	0	1	21	1	2	0	2
South Blackduck (BDS)	0	0	0	0	0	0	0	0	16	1	2	0
North Arvilla (NAR)	0	0	0	0	1	0	2	0	2	10	0	4
South Arvilla (SAR)	0	0	0	0	0	1	0	1	0	2	19	2
Devils Lake-Sourisford (DLS)	0	0	0	0	1	1	1	2	1	1	0	12

Table 4-10 (continued).

Actual Group	# Mis-identified	N	% Accurate
Paleoindian (PI)	0	1	100.0
Pelican Rapids (PLRP)	0	1	100.0
Prairie Archaic (PAR)	0	3	100.0
Eastern Archaic (EAR)	0	4	100.0
Woodland (WD)	0	6	100.0
Sonota (SON)	2	10	80.0
Late Woodland (LW)	1	15	93.3
North Blackduck (BDN)	6	27	77.8
South Blackduck (BDS)	3	19	84.2
North Arvilla (NAR)	9	19	52.6
South Arvilla (SAR)	6	25	76.0
Devils Lake-Sourisford (DLS)	7	19	63.2

* 77.2% of original grouped individuals correctly identified as to group of origin

The Late Prehistoric Series

Intergroup Relationships: Late Woodland, Oneota, Middle Missouri, and Mississippian Series

The crania of 169 individuals, representing various archaeological contexts within the Late Woodland, Oneota, Middle Missouri, and Mississippian traditions, are included in this analysis. This series will clarify population relationships during the Late Prehistoric period (ca. 1,100 - 350 B.P.). The cranial samples for the Late Woodland, Oneota, and Middle Missouri traditions are the largest in the study sample and represent the most influential archaeological manifestations of this period. A majority of the groups included in this analysis lived within the southern half of the study region. During the Late Prehistoric period, this area was characterized by "a resource-rich gallery forest bordered by rolling upland prairies [and]... stream-dissected terrain, including the heavily dissected Driftless Area [in southeastern Minnesota], which was covered by southern deciduous hardwood forest interspersed with extensive prairie openings" (Gibbon 1994:128). Table 3-1 lists the archaeological phases, sites, and corresponding samples sizes for each tradition. The means and standard deviations of each measurement by phase and sex are reported in Tables 2-1 in Appendix 1.

Thirteen canonical discriminant functions describe the group space in the current analysis. The first three discriminant functions are statistically significant at the .05 level of probability suggesting significant heterogeneity of the groups. The first two functions account for 21.5% and 18.0% of the intergroup variability, respectively.

Predictor Variable Set

Table 4-11 presents the results of the one-way ANOVA tests by variable for the sample. Statistically significant *F* ratios were obtained for 16 of the 41 measurements (39.0%). Three of the 16 variables, maximum cranial breadth (XCB), asterionic breadth (ASB), and minimum frontal breadth (WFB) reflect vault breadth. Three more variables, bizygomatic breadth (ZYB), simotic chord (WNB), and external palate breadth (MAB) measure various aspects of facial breadth. Also statistically significant is the occipital subtense (OCS) which measures prominence of the occipital squama. A review of the group means highlights a more prominent occipital squama in the Late Woodland groups, the relatively more narrow face and vault in the Oneota and Middle Missouri groups, and the distinctive, more gracile morphology of the Cambria individual. The distinctiveness of the Cambria cranium, however, could be due to sampling error.

The standardized discriminant function coefficients for the first two functions displayed in Table 4-12. Several variables that are indicative of vault height (basion-bregma height, BBH; basion radius, BAR; lambda radius LAR), cranial length (maximum length, GOL; parietal fraction, PAC), and occipital prominence (occipital subtense, OCS; lambda radius, LAR) define DF1. Seven of the 16 variables that are statistically significant in the univariate analysis are represented in the highest loading on DF 1. Additional variables that contribute most significantly to the first discriminant function represent length of the malar bone. The second discriminant function represents 18.0% of the total between-group variance. The most heavily weighted variables primarily reflect various components of facial breadth and include minimum frontal

Table 4-11. Results of an Analysis of Variance of Group Means per Variable: Late Prehistoric Series.

Measurement	F-value	Significance
Max. Cranial L. (GOL)	1.994	.025*
Max. Cranial B. (XCB)	2.905	.001*
Basion-Nasion L.(BNL)	0.997	.457
Basion-Bregma L. (BBH)	2.596	.003*
Min. Frontal B.(WFB)	2.950	.001*
Upper Facial H. (NAH)	1.316	.209
Bizygomatic B.(ZYB)	2.856	.001*
Biasterion B.(ASB)	2.227	.011*
Basion-prosthion L.(BPL)	1.770	.052
Nasal H. (NHH)	1.129	.339
Nasal B. (NLB)	0.666	.794
Ext. Palatal B. (MAB)	2.661	.002*
Ext. Palatal L. (MAL)	2.702	.002*
Mastoid B. (MBD)	2.212	.011*
Orbit H. (OBH)	1.484	.129
Orbit B. (OBB)	1.712	.063
Interorbital B. (DKB)	0.991	.462
Simotic Chord (WNB)	2.174	.013*
Bimaxillary B. (ZMB)	1.457	.140
Zygomaxillary S. (SSS)	1.660	.075
Bifrontal B. (FMB)	1.206	.280
Nasio-frontal S.(NAS)	1.038	.418
Inferior Malar L. (IML)	1.229	.264
Max. Malar L. (XML)	3.831	.000*
Malar S. (MLS)	1.756	.055

Table 4-11 (continued).

Measurement	F-value	Significance
Min. Cheek H. (WMH)	1.656	.076
Supraorbital Proj. (SOS)	2.267	.009*
Glabella Proj. (GLS)	1.017	.438
Frontal Chord (FRC)	1.268	.238
Frontal S. (FRS)	0.553	.888
Frontal Fraction (FRF)	1.821	.044*
Parietal Chord (PAC)	1.126	.341
Parietal S. (PAS)	0.783	.677
Parietal Fraction (PAF)	2.463	.005*
Occipital Chord (OCC)	1.552	.105
Occipital S. (OCS)	2.203	.012*
Occipital Fraction (OCF)	1.418	.157
For. Mag. B. (FOB)	2.076	.018*
Ectoconshion R. (EKR)	1.189	.292
Lambda R. (LAR)	1.050	.407
Basion R. (BAR)	1.295	.221

Note: df1 = 11, df2 = 137
* Significant at the 0.05 probability level

Table 4-12. Standardized Discriminant Function Coefficients: Late Prehistoric Period Series.

Discriminant Function	Highest Variable Loading			
1	BBH	-0.746	XML	-0.466
	PAF	0.527	EKR	0.450
	OCS	0.522	SOS	-0.438
	IML	0.520	BAR	0.418
	WMH	0.494	FOB	0.406
	GOL	-0.478	LAR	0.402
2	WFB	-0.623	BPL	-0.308
	BNL	0.617	DKB	0.303
	XML	-0.458	PAS	0.270
	MAL	-0.406	WNB	-0.266
	ZYB	-0.386	FRF	0.258
	IML	0.346	OCS	0.258

DF 1: 21.5% Variation Represented
DF 2: 18.0% Variation Represented

breadth (WFB), bizygomatic breadth (ZYB), interorbital breadth (DKB), and simotic chord (WNB). Interestingly, DF 2 reflects distinctiveness between groups in the length of the malar bones, similar to DF 1. Seven of the 16 measurements that were statistically significant in the univariate analysis also contribute significantly to the ability of the second function to discriminate between groups.

Biological Distance

Table 4-13 summarizes the group centroids for the first and second discriminant functions. Figure 4-5 illustrates the intergroup relationships defined by the same functions. Immediately apparent is the displacement of Mill Creek and Vermillion Bluff, the cluster of Late Woodland groups and burial complexes, and the more loosely defined grouping of the remainder of the Oneota and Middle Missouri tradition samples. Several interesting relationships can be noted. First, the centroid representing the northern concentration of Blackduck sites (BDN) is situated away from the other Late Woodland groups, and particularly the southern Blackduck group (BDS). Second, groups that occupied areas near each other geographically and were either contemporaneous or, at least, overlapped during some segment of their temporal range, do not always exhibit a closer biological relationship (e.g., Big Stone phase, BST; south Arvilla SAR). Third, whereas the Woodland groups for a tight cluster, the Oneota and Middle Missouri groups are integrated and more widely distributed. Finally, the placement of the burial complexes with the Late Woodland groups indicates that these burial complexes were likely the mortuary sites of Woodland peoples; the Oneota and Middle Missouri groups are quite distant from the burial complexes.

Table 4-13. Group Centroids in Reduced Space: Late Prehistoric Period Series.

Group	Discriminant Function 1	Discriminant Function 2
Late Woodland (LW)	-2.120	-0.02722
North Arvilla (NAR)	-0.735	0.0529
South Arvilla (SAR)	-0.283	-0.919
Devils Lake-Sourisford (DLS)	-0.107	-0.698
Great Oasis (GRO)	2.075	-1.491
Cambria (CAM)	2.174	2.185
Big Stone (BST)	1.433	1.410
Mill Creek (MCR)	3.048	-3.329
Vermillion Bluff (VBL)	-0.445	-2.994
Blue Earth (BE)	0.907	-0.281
Orr (ORR)	1.867	0.809
Silvernale (SIL)	1.079	2.610
North Blackduck (BDN)	0.068	1.483
South Blackduck (BDS)	-1.072	-0.317
Percent Variation Represented	21.5%	18.0%

Total Variation Represented: 39.5%

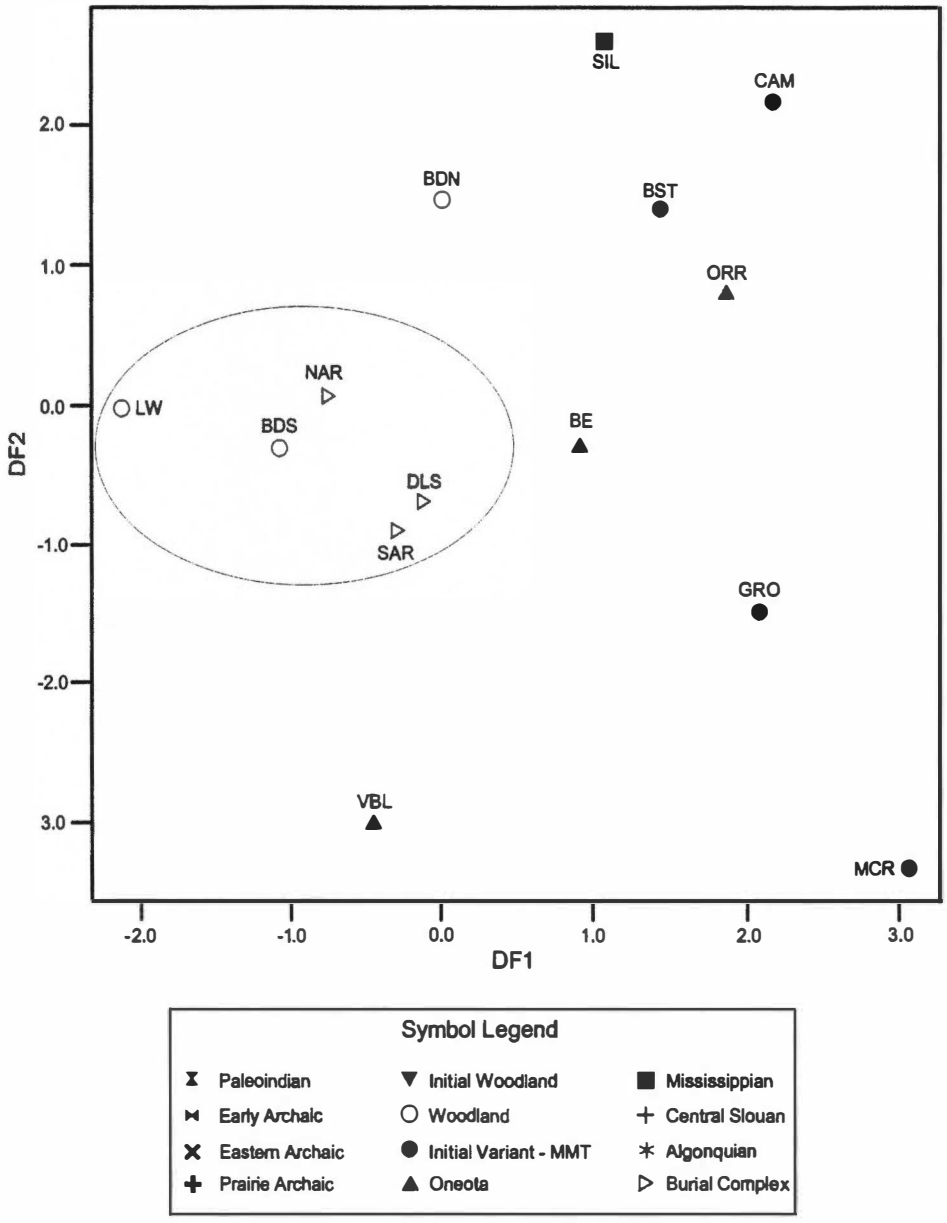


Figure 4-5. Scatterplot of Group Centroids Along Discriminant Functions 1 and 2: Late Prehistoric Series.

Group Classification

Table 4-14 summarizes the accuracy of the discriminant functions in identifying original group membership for each individual cranium in the Woodland, Oneota, Plains Village, and Mississippian series. Approximately 81.7% of the original grouped cases were correctly classified by the discriminant functions. Such a high percentage of accuracy suggests there are distinctive patterns of cranial morphology that characterize each group. Similar to the previous analysis, the Devils Lake-Sourisford (DLS) and northern Arvilla (NAR) have the poorest correct classification rates with 68.4% and 63.2% accuracy. The Blackduck groups follow with 73.7% for BDS and 77.8% for BDN. Misidentified individuals are most likely to be classified into Devils Lake-Sourisford (10/31) and Arvilla south (5/31).

Late Prehistoric and Historic Series

Intergroup Relationships

The crania of 281 individuals define the group space in this analysis. They represent the Oneota, Middle Missouri, Mississippian, and Late Woodland groups, as well as 12 historic tribes/bands known to have occupied territories in the study region during the early span of the Historic Period. See Tables 3-1 and 3-2 for a listing of the groups and corresponding sample sizes. A discriminant function analysis of the Late Prehistoric and Historic subsample will provide insight into possible ancestor-descendant relationships in the study region. Representation of all historic tribes present in the region is unavoidably incomplete. Crania of Iowa and Oto individuals from the same period as the other historic samples do not appear to exist and the Cree, Winnebago, and Mdewakanton

Table 4-14. Accuracy of Group Membership Predictions: Late Woodland, Oneota, Middle Missouri,and Mississippian Series.

Actual Group	LW	BDN	BDS	NAR	SAR	DLS	GRO	CAM	BST	MCR	VBL	BE	ORR	SIL
Late Woodland (LW)	12	0	2	0	1	0	0	0	0	0	0	0	0	0
North Blackduck (BDN)	0	21	1	1	1	2	0	0	1	0	0	0	0	0
South Blackduck (BDS)	0	0	16	1	1	2	0	0	0	0	0	1	0	0
North Arvilla (NAR)	2	0	1	12	0	3	1	0	0	0	0	0	0	0
South Arvilla (SAR)	0	0	0	0	21	2	0	0	1	0	0	1	0	0
Devils Lake Sourisford (DLS)	1	1	0	0	1	13	2	0	0	0	0	1	0	0
Great Oasis (GRO)	0	0	0	0	0	0	7	0	0	0	0	0	0	0
Cambria (CAM)	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Big Stone (BST)	0	0	0	0	0	0	0	0	9	0	0	0	0	0
Mill Creek (MCR)	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Vermillion Bluff (VBL)	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Blue Earth (BE)	0	0	0	0	1	1	0	0	0	0	0	6	0	0

Table 4-14 (continued).

Actual Group	LW	BDN	BDS	NAR	SAR	DLS	GRO	CAM	BST	MCR	VBL	BE	ORR	SIL
Orr (ORR)	0	0	0	0	0	0	0	0	0	0	0	0	13	0
Silvernale (SIL)	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Table 4-14 (continued).

Actual Group	# Mis-identified	N	% Accurate
Late Woodland (LW)	3	15	80.0
North Blackduck (BDN)	6	27	77.8
South Blackduck (BDS)	5	19	73.7
North Arvilla (NAR)	7	19	63.2
South Arvilla (SAR)	4	25	84.0
Devils Lake Sourisford (DLS)	6	19	68.4
Great Oasis (GRO)	0	7	100.0
Cambria (CAM)	0	1	100.0
Big Stone (BST)	0	9	100.0
Mill Creek (MCR)	0	4	100.0
Vermillion Bluff (VBL)	0	1	100.0
Blue Earth (BE)	2	8	75.0

Table 4-14 (continued).

Actual Group	# Mis-identified	N	% Accurate
Orr (ORR)	0	13	100.0
Silvernale (SIL)	0	2	100.0

* 81.7% of original grouped individuals correctly identified as to group of origin

samples are very small. On the other hand, reasonable sample sizes of the remaining 10 tribes (Cheyenne, Oglala, Yankton, Teton, Santee, Sisseton-Wahpeton, Ojibwa, Assiniboine, and Siouan) are included. The Late Prehistoric cranial sample is also representative of the time period and is comprised of a majority of all defined archaeological phases. Given the quality of the sample a discriminant function analysis of this sample will be informative and contribute significant information to the understanding of past population relationships.

Twenty-five canonical discriminant functions define the group space. The first six functions are significant at the 0.05 level. The first discriminant function accounts for 15.6% of intergroup variation and DF 2, for 13.8 %. A plot of group centroids along DF 1 and DF 2 is presented in Figure 4-6. The pattern of group distribution represents 29.4% of intergroup variability.

Predictor Variable Set

Table 4-15 presents the results of a one-way ANOVA by variable for the sample. The group means of 27 measurements (65.9%) varied significantly among the Late Prehistoric and Historic groups. With this many statistically significant variables, a wide array of cranio-facial complexes are represented including vault length (maximum cranial length, GOL; parietal chord, PAC; occipital chord, OCC), vault breadth (maximum cranial breadth, XCB; minimum frontal breadth, WFB; bizygomatic breadth, ZYB; biasterion breadth, ASB), curvature along the sagittal plane (occipital subtense, OCS; occipital fraction, OCF; parietal fraction, PAF; lambda radius, LAR), upper facial breadth (minimum cranial breath, WFB; interorbital breadth, DKB; zygomaxillary

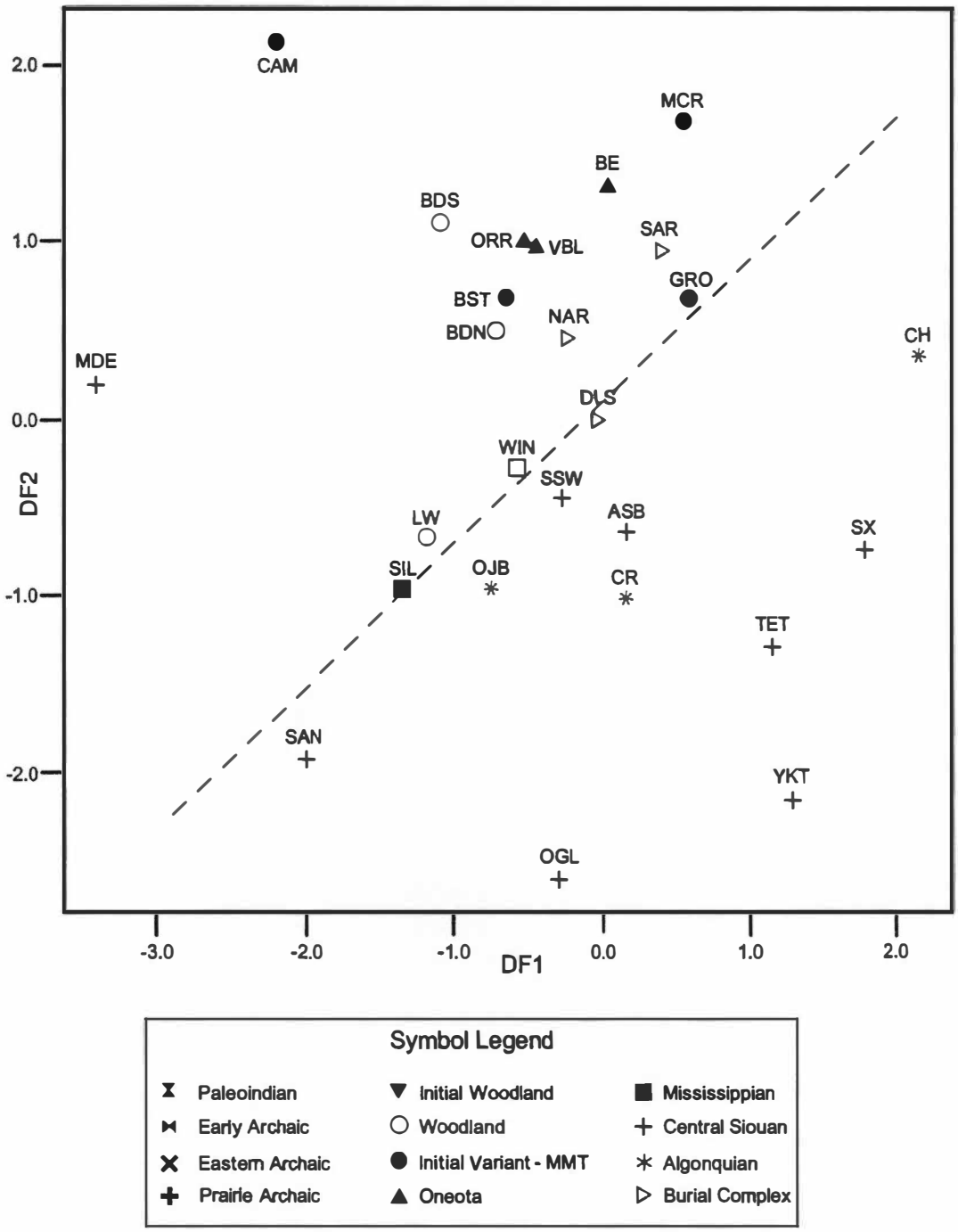


Figure 4-6. Scatterplot of Group Centroids Along Discriminant Function 1 and 2: Late Prehistoric and Historic Series.

Table 4-15. Results of an Analysis of Variance of Group Means per Variable: Late Prehistoric and Historic Series.

Measurement	F-value	Significance
Max. Cranial L. (GOL)	2.565	.000*
Max. Cranial B. (XCB)	2.390	.000*
Basion-Nasion L.(BNL)	1.322	.145
Basion-Bregma L. (BBH)	2.213	.001*
Min. Frontal B.(WFB)	2.289	.001*
Upper Facial H. (NAH)	1.687	.024*
Bizygomatic B.(ZYB)	2.177	.001*
Biasterion B.(ASB)	2.109	.002*
Basion-prosthion L.(BPL)	1.218	.223
Nasal H. (NHH)	1.022	.439
Nasal B. (NLB)	0.898	.608
Ext. Palatal B. (MAB)	2.482	.000*
Ext. Palatal L. (MAL)	1.686	.024*
Mastoid B. (MBD)	1.589	.041*
Orbit H. (OBH)	2.146	.002*
Orbit B. (OBB)	4.855	.000*
Interorbital B. (DKB)	3.086	.000*
Simotic Chord (WNB)	1.628	.033*
Bimaxillary B. (ZMB)	2.184	.001*
Zygomaxillary S. (SSS)	1.648	.030*
Bifrontal B. (FMB)	1.705	.022*
Nasio-frontal S.(NAS)	1.233	.210
Inferior Malar L. (IML)	1.384	.111
Max. Malar L. (XML)	3.537	.000*

Table 4-15 (continued).

Measurement	F-value	Significance
Malar S. (MLS)	1.707	.022*
Min. Cheek H. (WMH)	1.779	.015*
Supraorbital Proj. (SOS)	2.113	.002*
Glabella Proj. (GLS)	1.062	.388
Frontal Chord (FRC)	0.903	.602
Frontal S. (FRS)	0.664	.889
Frontal Fraction (FRF)	1.514	.060
Parietal Chord (PAC)	1.688	.024*
Parietal S. (PAS)	1.311	.152
Parietal Fraction (PAF)	1.993	.004
Occipital Chord (OCC)	2.372	.000*
Occipital S. (OCS)	2.760	.000*
Occipital Fraction (OCF)	1.912	.007*
For. Mag. B. (FOB)	1.376	.114
Ectoconshion R. (EKR)	1.471	.074
Lambda R. (LAR)	1.988	.004*
Basion R. (BAR)	1.375	.115

Note: df1 = 25, df2 = 255

* Significant at the 0.05 probability level

breadth, ZMB; bifrontal breadth, FMB; simotic chord, WNB), anterior facial projection (external palatal length, MAL; zygomaxillary subtense, SSS; malar subtense, MLS), and orbital shape (orbit breadth, OBB; orbit heigh, OBH). A review of group means identifies some of the trends seen in the previous analysis (Late Prehistoric series), namely, the distinctive occipital morphology in the Late Woodland groups and the more narrow face and vault of the Oneota and Middle Missouri groups. Most distinctive in the prehistoric groups is a Mill Creek female who exhibits a very gracile and petite morphology. Relative to the historic groups, the Mdewakanton male is distinctively small in nearly every dimension. A majority of the Historic groups exhibit broader faces than the prehistoric groups; the exception to this is the Yankton sample which is characterized by more narrow faces. The Oglala and Cheyenne exhibit particularly broad upper faces. Overall the morphology of the historic sample, relative to the measurements that are significant for this series, shows little in the way of distinct morphological patterns. The historic groups do sort, to a degree, according to major language affiliation; Siouan, Algonquian, and Chiwere Siouan groups do cluster according to language affiliation.

The standardized discriminant function coefficients of DF 1 and DF 2 are presented in Table 4-16. Measurements of facial breadth (interorbital breadth, DKB; zygomaxillary breadth, ZMB; bifrontal breadth, FMB; simotic chord WNB) and projection of the anterior face (zygomaxillary subtense, SSS; ectoconshion radius, EKR; basion-prosthion length, BPL) remain important in distinguishing between-group variation from the previous comparison and define, to a large part, the first discriminant

Table 4-16. Standardized Discriminant Function Coefficients: Late Prehistoric and Historic Series.

Discriminant Function	Highest Variable Loading			
1	XML	-0.748	BPL	-0.359
	SSS	0.555	ZYB	0.358
	EKR	0.490	LAR	0.331
	IML	0.442	WMH	0.307
	DKB	-0.401	FMB	-0.285
	ZMB	-0.382	WNB	0.249
2	PAC	-0.603	OCC	-0.335
	OCS	0.586	OBB	0.345
	WFB	0.518	BNL	-0.305
	SOS	-0.451	ZMB	0.274
	DKB	-0.419	SSS	-0.247
	OCF	-0.372	MBD	-0.230

DF 1: 15.6% Variation Represented
DF 2: 13.8% Variation Represented

function. Table 4-15 shows that group means of nine of the twelve measurements that define DF 1 also exhibit significant differences as isolated variables. Occipital morphology (occipital chord, OCC; occipital subtense, OCS; occipital fraction, OCF), although not so much length relative to maximum cranial length, and the orbital area of the face (orbital breadth, OBB; interorbital breadth, DKB) are important complexes in DF2. Not surprisingly, 11 of the 12 variables that most significantly define DF2, are significant in the univariate analysis. The two discriminant functions represent a total of 29.4 % of intergroup variation.

Biological Distance

The coefficients of each group centroid for discriminant functions 1 and 2 are listed in Table 4-17. Figure 4-6 illustrates the intergroup relationships along these three functions and some interesting associations are observable. Immediately visible are the outliers. Cambria and the Mdewakanton, clearly distinct in their cranial morphology, are displaced from the rest of the groups. Cambria, at least, is displaced from the other Late Prehistoric groups. The Mdewakanton individual, however, is situated far from all of the Siouan groups. It is noteworthy to recall that each of these two "groups" is represented by a single individual and it is very likely that what is being viewed here is the result of sampling error. Without considering Cambria and Mdewakanton further, three clusters are observable. First, and quite distinct, is the association between the Teton, Yankton, general Siouan, Cheyenne, and less so, the Oglala groups; they are most tightly clustered along the positive values of DF 1, sharing similarities in facial breadth and projection of the anterior face. A second cluster contains a mixture of late prehistoric and historic

Table 4-17. Group Centroids in Reduced Space: Late Prehistoric and Historic Series.

Group	Discriminant Function 1	Discriminant Function 2
Late Woodland (LW)	-1.182	-0.657
North Arvilla (NAR)	-0.230	0.467
South Arvilla (SAR)	0.414	0.956
Devils Lake-Sourisford (DLS)	-0.027	0.010
Great Oasis (GRO)	0.586	0.692
Cambria (CAM)	-2.212	2.132
Big Stone (BST)	-0.655	0.700
Mill Creek (MCR)	0.548	1.695
Vermillion Bluff (VBL)	-0.453	0.987
Blue Earth (BE)	0.040	1.336
Orr (ORR)	-0.537	1.027
Silvernale (SIL)	-1.344	-0.950
North Blackduck (BDN)	-0.720	0.505
South Blackduck (BDS)	-1.092	1.113
Assiniboine (ASB)	0.160	-0.631
Cheyenne (CH)	2.138	0.369
Cree (CR)	0.151	-1.006
Ojibwa (OJB)	-0.767	-0.952
Mdewakanton (MDE)	-3.394	0.205

Table 4-17 (continued).

Group	Discriminant Function 1	Discriminant Function 2
Oglala (OGL)	-0.305	-2.601
Santee (SAN)	-2.009	-1.923
Sisseton-Wahpeton (SSW)	-0.273	-0.436
Teton (TET)	1.146	-1.280
Yankton (YKT)	1.278	-2.153
Sioux (SX)	1.770	-0.727
Winnebago (WIN)	-0.589	-0.269
Percent Variation Represented	15.6%	13.8%

Total Variation Represented: 29.4%

groups. The pattern of relationships, however, is telling. The historic groups in the cluster, the Algonquian-speaking Ojibwa and Cree, and the Siouan-speaking Assiniboine, Santee and Sisseton - Wahpeton border the cluster and "face" the first cluster of western Sioux. Within this grouping, the Santee are somewhat displaced. The other component of the second cluster, consists of the Woodland groups, Devils Lake-Sourisford and Late Woodland, the Mississippian Silvernale, and, strangely, the Winnebago. Only sections of this arrangement can be reasonably explained. The "historic" border of this cluster reflects, in part, the separation of the Algonquian tribes (Ojibwa and Cree) from the western Siouan groups (Yankton, Teton, Oglala). It is of little surprise that the Assiniboine assort with the Algonquians since they are known to have split from their Teton relatives sometime before European contact. Relations between the Assiniboine and the Siouan groups were, for the most part, antagonistic and during the 1700s the Assiniboine allied themselves with the Cree, and later, Ojibwa. The proximity of the Cheyenne to this cluster of western Siouan groups is also reasonable given their geographic proximity to these groups in the 1700s. The Woodland, Mississippian (Silvernale), Winnebago association seems anomalous. It may be possible that the Mississippian Silvernale interacted with the protohistoric Winnebago due to geographic overlap, however, the possibility of any interaction between Devils Lake-Sourisford and the Winnebago seems highly unlikely due to geographic distance. The conclusion for this cluster must be that the heterogeneity that characterizes the Devils Lake-Sourisford group clouds its intergroup interaction. The Woodland, Mississippian, and Winnebago border is adjacent and moderately separated from the third cluster. This final grouping is

comprised entirely of Late Prehistoric groups. All of the Middle Missouri phases are present, as are all of the Oneota phases. Interspersed within are the Woodland Blackduck South, Blackduck North, South Arvilla, and North Arvilla groups. The northern and southern Arvilla groups are fairly close together, but the north and south Blackduck groups are more widely separated, supporting the separation of the Blackduck phase into two geographic groups for the present study. All three Oneota groups, Vermillion Bluff, Orr, and Blue Earth, cluster closely together. This close association reflects the overall similarity of the Oneota samples when evaluated with the historic samples. Finally, the Initial variant groups of the Middle Missouri tradition are widely separated within the Late Prehistoric cluster indicating affinities with Oneota and Woodland groups. They do not show any close affinities to any of the historic groups. Interestingly, Great Oasis is situated near the Arvilla groups, reflecting, possibly, the disagreement among archaeologists regarding its classification as either Woodland or Initial variant of the Middle Missouri Tradition.

Group Classification

The percent of individuals accurately identified as to group of origin is presented in Table 4-18. Devils Lake-Sourisford is once again characterized by the least morphological, and consequently, genetic, homogeneity with a very low rate of correct classification at 42.1%. Also characterized by significant heterogeneity is the northern Blackduck group with 48.0% accuracy. The northern Arvilla group is also characterized by significant heterogeneity as exemplified by a 56.9% accurate group prediction rate. It is noteworthy that two of the most heterogenous groups are burial complexes. Their

Table 4-18. Accuracy of Group Membership Predictions: Late Prehistoric and Historic Series.

Actual Group	LW	BDN	BDS	NAR	SAR	DLS	GRO	CAM	BST	MCR	VBL	BE	ORR
Late Woodland (LW)	10	0	1	0	1	1	0	0	0	0	0	0	1
North Blackduck (BDN)	1	13	2	1	1	1	0	0	1	0	0	0	0
South Blackduck (BDS)	0	1	13	1	2	0	0	0	0	0	0	1	0
North Arvilla (NAR)	2	0	1	11	0	2	1	0	0	0	0	0	0
South Arvilla (SAR)	0	0	0	0	21	2	0	0	0	0	0	0	0
Devils Lake Sourisford (DLS)	1	1	0	1	1	8	1	0	0	0	0	1	0
Great Oasis (GRO)	0	0	0	0	0	0	6	0	0	0	0	0	0
Cambria (CAM)	0	0	0	0	0	0	0	1	0	0	0	0	0
Big Stone (BST)	0	0	0	0	0	0	0	0	8	0	0	1	0
Mill Creek (MCR)	0	0	0	0	0	0	0	0	0	4	0	0	0
Vermillion Bluff (VBL)	0	0	0	0	0	0	0	0	0	0	1	0	0
Blue Earth (BE)	0	0	0	0	1	1	0	0	0	0	0	6	0
Orr (ORR)	0	1	0	0	0	1	0	0	0	0	0	1	9
Silvernale (SIL)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-18 (continued).

Actual Group	LW	BDN	BDS	NAR	SAR	DLS	GRO	CAM	BST	MCR	VBL	BE	ORR
Assiniboine (ASB)	0	0	0	0	0	1	0	0	0	0	0	0	0
Cheyenne (CH)	0	0	0	0	0	0	0	0	0	0	0	0	0
Cree (CR)	0	0	0	0	0	0	0	0	0	0	0	0	0
Ojibwa (OJB)	1	0	1	0	0	0	0	0	0	0	0	1	1
Mdewakanton (MDE)	0	0	0	0	0	0	0	0	0	0	0	0	0
Oglala (OGL)	0	0	0	0	0	0	0	0	0	0	0	0	0
Santee (SAN)	0	0	0	0	0	0	0	0	0	0	0	0	0
Sisseton-Wahpeton (SSW)	0	0	0	0	0	0	0	0	0	0	0	0	0
Teton (TET)	0	1	0	0	0	0	0	0	0	0	0	0	0
Yankton (YKT)	0	0	0	0	0	0	0	0	0	0	0	0	0
Siouan (SX)	0	0	0	0	0	1	0	0	0	0	0	0	1
Winnebago (WIN)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-18 (continued).

Actual Group	SIL	ASB	CH	CR	OJB	MDE	OGL	SAN	SSW	TET	YKT	SX	WIN
Late Woodland (LW)	0	0	0	0	1	0	0	0	0	0	0	0	0
North Blackduck (BDN)	1	1	0	0	3	0	0	0	0	0	0	0	1
South Blackduck (BDS)	0	0	1	0	0	0	0	0	0	0	0	0	0
North Arvilla (NAR)	0	0	0	0	1	0	0	0	0	0	0	1	0
South Arvilla (SAR)	0	1	0	0	0	0	1	0	0	0	0	0	0
Devils Lake Sourisford (DLS)	0	0	0	0	1	0	0	0	1	0	0	3	0
Great Oasis (GRO)	0	0	0	0	0	0	0	0	0	0	0	1	0
Cambria (CAM)	0	0	0	0	0	0	0	0	0	0	0	0	0
Big Stone (BST)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mill Creek (MCR)	0	0	0	0	0	0	0	0	0	0	0	0	0
Vermillion Bluff (VBL)	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue Earth (BE)	0	0	0	0	0	0	0	0	0	0	0	0	0
Orr (ORR)	0	0	0	0	1	0	0	0	0	0	0	0	0
Silvernale (SIL)	2	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-18 (continued).

Actual Group	SIL	ASB	CH	CR	OJB	MDE	OGL	SAN	SSW	TET	YKT	SX	WIN
Assiniboine (ASB)	0	6	0	0	0	0	0	0	0	1	0	0	0
Cheyenne (CH)	0	0	21	0	0	0	0	0	1	0	0	0	0
Cree (CR)	0	0	0	1	0	0	0	0	0	0	0	0	0
Ojibwa (OJB)	0	0	1	0	9	0	0	0	0	0	1	1	0
Mdewakanton (MDE)	0	0	0	0	0	1	0	0	0	0	0	0	0
Oglala (OGL)	0	0	0	0	2	0	8	0	0	0	1	0	0
Santee (SAN)	0	1	0	0	0	0	1	7	1	0	0	0	0
Sisseton-Wahpeton (SSW)	0	0	0	0	0	0	0	0	3	0	0	0	0
Teton (TET)	0	1	0	0	0	0	0	0	0	8	0	0	0
Yankton (YKT)	0	0	0	0	0	0	0	0	0	0	4	0	0
Siouan (SX)	0	1	0	0	0	0	0	0	0	1	0	19	0
Winnebago (WIN)	0	0	0	0	0	0	0	0	0	0	0	0	3

Table 4-18 (continued).

Actual Group	# Mis-identified	N	% Accurate
Late Woodland (LW)	5	15	66.7
North Blackduck (BDN)	14	27	48.0
South Blackduck (BDS)	6	19	68.4
North Arvilla (NAR)	8	19	56.9
South Arvilla (SAR)	4	25	84.0
Devils Lake Sourisford (DLS)	11	19	42.1
Great Oasis (GRO)	1	7	85.7
Cambria (CAM)	0	1	100.0
Big Stone (BST)	1	9	88.9
Mill Creek (MCR)	0	4	100.0
Vermillion Bluff (VBL)	0	1	100.0
Blue Earth (BE)	2	8	75.0
Orr (ORR)	4	13	69.2
Silvernale (SIL)	0	1	100.0

Table 4-18 (continued).

Actual Group	# Mis-identified	N	% Accurate
Assiniboine (ASB)	2	8	75.0
Cheyenne (CH)	1	22	95.5
Cree (CR)	0	1	100.0
Ojibwa (OJB)	7	16	56.3
Mdewakanton (MDE)	0	1	100.0
Oglala (OGL)	3	11	72.7
Santee (SAN)	3	10	70.0
Sisseton-Wahpeton (SSW)	0	3	100.0
Teton (TET)	2	10	80.0
Yankton (YKT)	0	4	100.0
Siouan (SX)	4	23	82.6
Winnebago (WIN)	0	3	100.0

* 72.2% of original grouped individuals correctly identified as to group of origin

heterogeneity may very well reflect use of the burial mounds by many diverse groups. Reviewing the accuracy of group prediction for the historic sample is informative. The Ojibwa are the least likely to be identified accurately (56.3%). This very likely reflects the nature of the Ojibwa sample, however. Crania included in the Ojibwa sample are from several different sites or locales and the identification of several skulls as Ojibwa is questionable. In summary, the multivariate discriminant function analysis of the Late Prehistoric and Historic cranial series suggests that there is a significant degree of phenetic, and by extension, genetic heterogeneity in several of the groups considered. Two of the burial complexes exhibit a low percentage of accurate identification. Several groups are observed to be peripheral to the main concentration of groups; possibly a result of small sample sizes and sampling error. Finally, there is essentially little evidence for ancestor-descendant relationships between groups as indicated by the clear separation and placement of the prehistoric and historic groups.

All Groups Series

Intergroup Relationships

The final analysis considered during this project encompasses the entire cranial sample, from the Paleoindian period to post-European contact. Evaluation of intergroup distances in this context will provide a diachronic perspective on patterns of population integration and migration over the diverse landscape of the study region. Group space is defined by 306 individuals assorted into 32 groups representing the four broad time periods defined in Chapter 2. See Tables 3-2 and 3-3 for a listing of the groups and corresponding sample sizes.

Thirty-one canonical discriminant functions define the group space. The first six functions are significant at the 0.05 level. The first three discriminant functions will be considered in greater detail here and, in numerical order, represent 15.7%, 12.2%, and 10.0% of intergroup variation, respectively. Figure 4-7 displays each group centroid along the first two discriminant functions and Figure 4-8 provides a three-dimensional plot of group centroids defined by Discriminant Functions 1, 2, and 3.

Predictor Variable Set

Table 4-19 presents the results of a one-way ANOVA of group means per variable for the sample. Of the 41 measurement variables, 29, or 70.7%, are significant at the 0.05 level. Similar to the previous analysis of the Late Prehistoric and Historic Series, a wide array of cranio-facial complexes vary significantly across groups. Still significant to among-group differences are overall vault length (maximum cranial length, GOL; parietal chore, PAC; parietal fraction, PAF; occipital chord, OCC; occipital fraction, OCF, and lambda radius, LAR), vault breadth (maximum cranial breadth, XCB; minimum frontal breadth, WFB; biasterion breadth, ASB), upper facial breadth (bizygomatic breadth, ZYB; external palate breadth, MAB; interorbital breadth, DKB; simotic chord, WNB; bimaxillary breadth, ZMB), and more localized areas of the face and vault such as orbit shape (orbit breadth, OBB; orbit height, OBH; interorbital breadth, DKB; simotic chord, WNB), linear dimensions of the malar bone (inferior malar length, IML; maximum malar length, XML), and shape and prominence of the occipital bone (occipital chord, OCC; occipital fraction, OCF; occipital subtense, OCS; lambda radius, LAR). The similarity of morphological complexes identified as significant in a

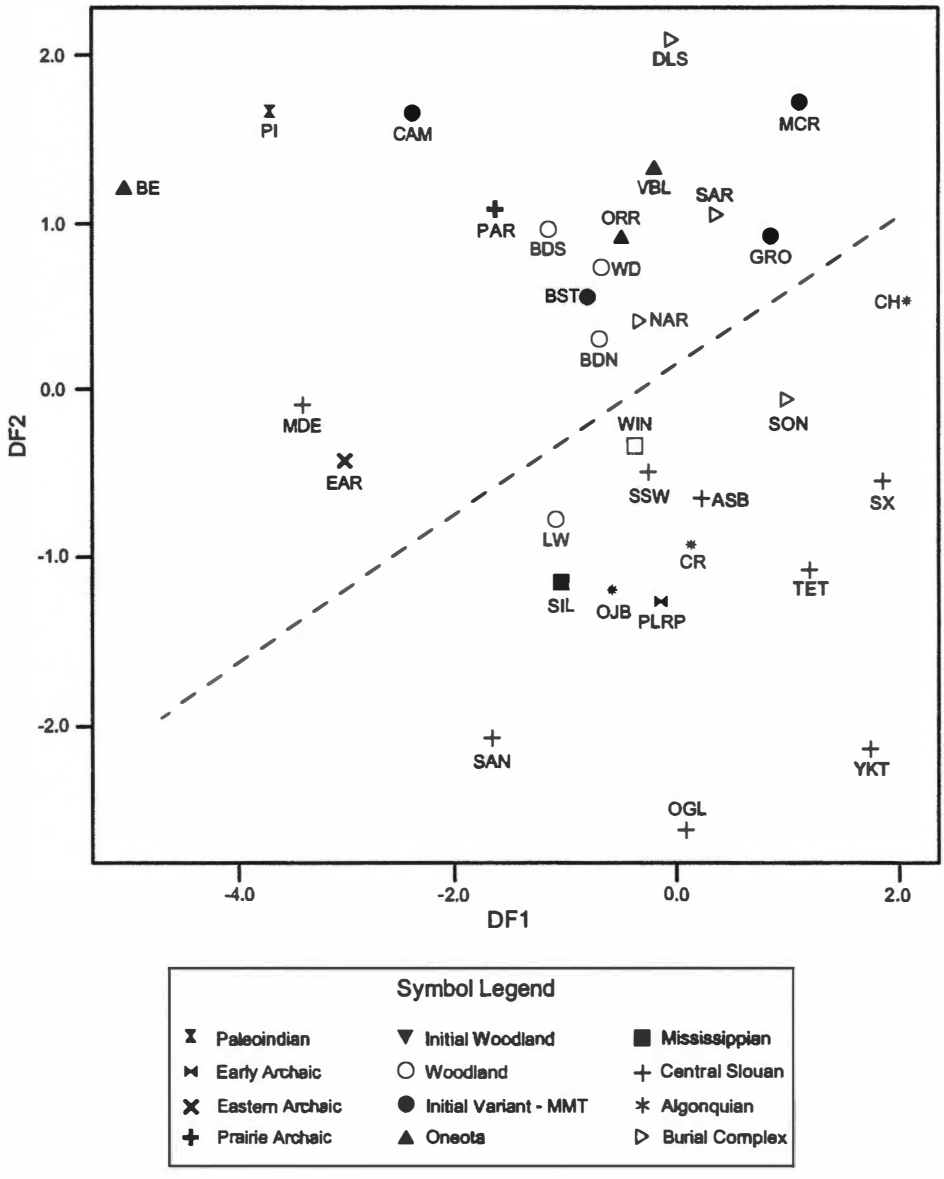
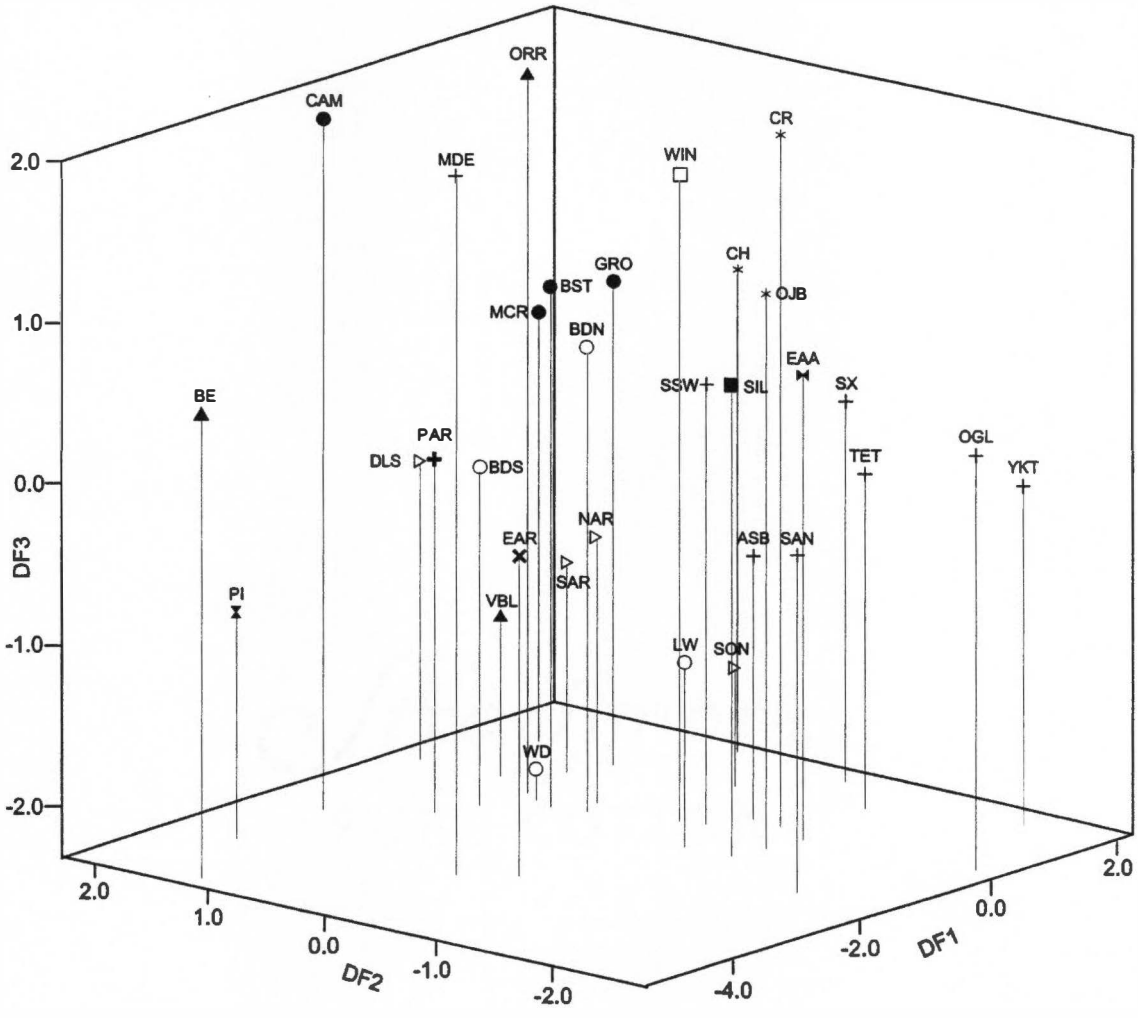


Figure 4-7. Scatterplot of Group Centroids Along Discriminant Functions 1 and 2: All Groups Series.



Symbol Legend

Paleoindian	Initial Woodland	Mississippian
Early Archaic	Woodland	Central Siouan
Eastern Archaic	Initial Variant - MMT	Algonquian
Prairie Archaic	Oneota	Burial Complex

Figure 4-8. Scatterplot of Group Centroids Along Discriminant Functions 1, 2, and 3: All Groups Series.

Table 4-19. Results of an Analysis of Variance of Group Means per Variable: All Groups Series.

Measurement	F-value	Significance
Max. Cranial L. (GOL)	2.447	.000*
Max. Cranial B. (XCB)	2.005	.002*
Basion-Nasion L.(BNL)	1.130	.297
Basion-Bregma L. (BBH)	2.062	.001*
Min. Frontal B.(WFB)	2.014	.002*
Upper Facial H. (NAH)	1.609	.025*
Bizygomatic B.(ZYB)	1.898	.004*
Biasterion B.(ASB)	1.828	.006*
Basion-prosthion L.(BPL)	1.224	.199
Nasal H. (NHH)	1.188	.233
Nasal B. (NLB)	0.947	.552
Ext. Palatal B. (MAB)	2.223	.000*
Ext. Palatal L. (MAL)	1.628	.022*
Mastoid B. (MBD)	1.597	.027*
Orbit H. (OBH)	1.908	.004*
Orbit B. (OBB)	4.133	.000*
Interorbital B. (DKB)	2.947	.000*
Simotic Chord (WNB)	1.542	.038*
Bimaxillary B. (ZMB)	2.084	.001*
Zygomaxillary S. (SSS)	1.555	.035*
Bifrontal B. (FMB)	1.718	.013*
Nasio-frontal S.(NAS)	1.096	.339
Inferior Malar L. (IML)	1.543	.038*
Max. Malar L. (XML)	3.326	.000*
Malar S. (MLS)	1.488	.052
Min. Cheek H. (WMH)	1.759	.010*

Table 4-19 (continued).

Measurement	F-value	Significance
Supraorbital Proj. (SOS)	1.867	.005*
Glabella Proj. (GLS)	1.211	.212
Frontal Chord (FRC)	0.810	.755
Frontal S. (FRS)	0.581	.965
Frontal Fraction (FRF)	1.192	.230
Parietal Chord (PAC)	1.511	.045*
Parietal S. (PAS)	1.123	.305
Parietal Fraction (PAF)	1.715	.013*
Occipital Chord (OCC)	2.429	.000*
Occipital S. (OCS)	2.623	.000*
Occipital Fraction (OCF)	1.847	.005*
For. Mag. B. (FOB)	1.168	.254
Ectoconshion R. (EKR)	1.767	.009*
Lambda R. (LAR)	2.354	.000*
Basion R. (BAR)	1.562	.034*

Note: df1 = 31, df2 = 274
* Significant at the 0.05 probability level

univariate context to those identified as significant in earlier analyses, suggests that even with the addition of more groups, that certain morphological expressions remain distinct across time and geography.

The standardized discriminant function coefficients of DF 1, DF 2, and DF 3 are introduced in Table 4-20. Most important to the delineation of DF 1 are measures of facial breadth (bizygomatic breadth, ZYB; interorbital breadth, DKB; zygomaxillary breadth, ZMB; bifrontal breadth, FMB), malar morphology (inferior malar length, IML; maximum malar length, XML; minimum cheek height, WMH), and anterior facial projection (zygo-maxillare subtense, SSS; ectoconshion radius, EKR; and basion-prosthion length, BPL). Eleven of 12 of the measurements identified as significant in the ANOVA are listed in the top 12 contributors to DF1. Occipital morphology (occipital chord, OCC; occipital fraction, OCF; occipital subtense, OCS), dimensions of the orbit and interorbital area (orbit breadth, OBB; interorbital breadth, DKB; simotic subtense, WNB), and overal cranial length (parietal chord, PAC; occipital chord, OCC; and occipital fraction, OCF) figure prominently in DF 2. Of no great surprise is the shared presence of 11 of the 12 variables determined to significantly distinguish the included groups in the multivariate and univariate analyses. The third discriminant function reflects a diverse combination of variables, however, most heavily represented are measures important to describing the cranial base and cranial height (basion-bregma height, BBH; basion radius, BAR; and frontal subtense, FRS), cranial length (maximum cranial length, GOL; parietal fraction, PAF; frontal subtense, FRS), and projection of the

Table 4-20. Standardized Discriminant Function Coefficients: All Groups Series.

Discriminant Function	Highest Variable Loading			
1	XML	-0.768	ZYB	0.376
	SSS	0.512	DKB	-0.352
	EKR	0.508	BPL	-0.332
	LAR	0.465	ZMB	-0.332
	IML	0.424	MBD	0.292
	FMB	-0.378	WMH	0.274
2	OCS	0.531	OBB	0.368
	WFB	0.521	OCC	-0.346
	SOS	-0.493	BNL	-0.287
	DKB	-0.479	WNB	0.219
	PAC	-0.423	MBD	-0.208
	OCF	-0.379	BBH	0.205
3	BBH	-0.696	PAF	0.353
	MAL	-0.500	IML	0.338
	MLS	-0.448	EKR	0.277
	GOL	0.412	BPL	0.263
	BAR	0.388	SOS	-0.234
	OBB	-0.379	FRS	0.234

DF 1: 15.7% Variation Represented
DF 2: 12.2% Variation Represented
DF 3: 10.0% Variation Represented

face (supraorbital projection, SOS; ectoconshion radius, EKR; basion-prosthion length, BPL). As seen in the DF 1 and DF 2, 11 of 12 variables significant in the univariate analysis assist in the definition of the third discriminant function. Together the first three discriminant functions account for 37.9% of intergroup variation.

Biological Distance

Table 4-21 lists the coefficients for the centroid of each group for the first three discriminant functions. Group centroid coefficients of DF 1 and DF 2 are plotted and displayed in Figure 4-7. Since these two functions only represent 27.9% of the variation, a second scatterplot was constructed from the group centroids of the first three discriminant functions and show intergroup relations in three dimensions (Figure 4-8). The addition of the third canonical discriminant function accounts for an additional 10% of intergroup variation.

Both plots reflect similar intergroup associations. Considering Figure 4-7 first, two main clusters are observable. These consist of one group comprised of a mixture of Woodland, Oneota, and Middle Missouri Tradition phases, most of which are Late Prehistoric manifestations. The Prairie Archaic group, while still belonging to the cluster, is situated on the periphery. The sample of undifferentiated Woodland sites is placed slightly off-center and reflects a morphological pattern similar to the Late Prehistoric groups. More distant from this cluster are two loosely defined groups; one includes the Blue Earth Oneota, Paleoindian, and Cambria samples and the other consists of the Devils Lake-Sourisford and Mill Creek samples. A unifying factor in the Blue

Table 4-21. Group Centroids in Reduced Space: All Groups Series.

Group	DF 1	DF2	DF 3
Paleoindian (PI)	-3.719	1.671	-0.909
Pelican Rapids (PLRP)	-0.136	-1.268	0.588
Prairie Archaic (PAR)	-1.641	1.084	-0.123
Eastern Archaic (EAR)	-3.027	-0.422	-0.308
Late Woodland (LW)	-1.091	-0.768	-1.167
Sonota (SON)	0.980	-0.051	-1.566
North Arvilla (NAR)	-0.321	0.427	-0.668
South Arvilla (SAR)	0.355	1.063	-1.023
Devils Lake-Sourisford (DLS)	-0.029	0.021	-0.483
Great Oasis (GRO)	0.837	0.931	0.700
Cambria (CAM)	-2.384	1.660	1.981
Big Stone (BST)	-0.805	0.561	0.926
Mill Creek (MCR)	1.096	1.723	0.350
Vermillion Bluff (VBL)	-0.193	1.324	-1.300
Blue Earth (BE)	-0.056	1.217	0.572
Orr (ORR)	-0.507	0.915	2.160
Silvernale (SIL)	-1.050	-1.146	0.629
Assiniboine (ASB)	0.215	-0.643	-0.696
Cheyenne (CH)	2.066	0.532	0.674
Cree (CR)	0.133	-0.925	1.977

Table 4-21 (continued).

Group	DF 1	DF2	DF 3
Ojibwa (OJB)	-0.583	-1.185	1.129
Mdewakanton (MDE)	-3.411	-0.091	2.023
Oglala (OGL)	0.092	-2.626	0.248
Santee (SAN)	-1.673	-2.070	-0.204
Sisseton-Wahpeton (SSW)	-0.255	-0.487	0.423
Teton (TET)	1.182	-1.071	-0.246
Yankton (YKT)	1.729	-2.132	-0.222
Sioux (SX)	1.860	-0.535	0.035
Winnebago (WIN)	-0.367	-0.328	1.695
North Blackduck (BDN)	-0.687	0.311	0.550
South Blackduck (BDS)	-1.152	0.964	-0.240
Woodland (WD)	-0.691	0.742	-2.135
Percent Variation Represented	15.7%	12.2%	10.0%

Total Variation Represented: 37.9%

Earth-Paleoindian-Cambria cluster is their location within the Prairie Lakes region (Anfinson 1997). The peripheral placement of the Cambria and Paleoindian individuals may very well reflect sampling error given that each group is comprised of a single individual. The location of Browns Valley may also reflect its distinction as one of the earliest residents in present-day Minnesota; there are 9,000 years between the existence of Browns Valley and the Blue Earth and Cambria individuals! There is no obvious explanation for the Devils Lake-Sourisford association; this may just be fortuitous association since their territories are geographically quite distant. The second cluster is located below the Late Prehistoric cluster and is dominated by historic tribes. The undifferentiated Late Woodland group and the Mississippian Silvernale sample are located on the periphery of the cluster, and the Early Archaic Pelican Rapids (Minnesota Woman) individual is situated within the cluster. Clearly displaced from this cluster, as well as the Late Prehistoric one, is the Middle Woodland Sonota burial complex. This distinction may reflect its status as the only Middle Woodland group represented, as well as its western location. The Mdewakanton and the Eastern Archaic groups are displaced to the other side of the second cluster. This displacement most likely reflects the distinctive morphology of the Mdewakanton individual. The proximity of Mdewakanton to the Eastern Archaic sample is puzzling. Finally, a loose concentration of Siouan, primarily Western Siouan, groups is located in the lower right quadrant of the plot. Most of them are well removed from association with any prehistoric group. It is interesting to observe that the Cheyenne group is very near the undifferentiated Siouan, Teton and

Yankton groups when considering the first discriminant function. In summary, Figure 4-7 illustrates clear discontinuity between the historic and prehistoric groups; DF 2 clearly separates, with near perfection, the historic and prehistoric populations.

Figure 4-8 reflects many of the same relationships described above, most notably the separation of the historic from the prehistoric groups, the general association of the Western Siouan groups (and Pelican Rapids), and a small cluster of Algonquian-speakers. Nevertheless, the addition of the third discriminant function defines a more clear association between Middle Missouri groups (Mill Creek, MCR; Big Stone, BST; Great Oasis, GRO). Also interesting is the relative closeness of the northern and southern Arvilla groups and the more significant separation between the two Blackduck groups. Observable in both Figure 4-7 and 4-8 is the proximity of Silvernale to some of the historic groups and its distance from a majority of the prehistoric groups. This may very well reflect migration northward of a Mississippian enclave that settled in the Red Wing region. Such a significant conclusion, however, weighs heavily on a sample size of two individuals. The implications of the population relationships observed in the two scatterplots will be discussed in greater detail in Chapter 5.

Group Classification

The accuracy with which group membership is predicted is summarized in Table 4-22. Overall, 71.9% of all individuals are accurately identified as to their group of origin. This reasonably high prediction rate indicates that there are, in fact, significant morphological differences throughout the study sample. Group membership is poorly

Table 4-22. Accuracy of Group Membership Predictions: All Groups Series.

Actual Group	PI	PLRP	PAR	EAR	WD	SON	LW	BDN	BDS	NAR	SAR	DLS	GRO
Paleoindian (PI)	1	0	0	0	0	0	0	0	0	0	0	0	0
Pelican Rapids (PLRP)	0	1	0	0	0	0	0	0	0	0	0	0	0
Prairie Archaic (PAR)	0	0	3	0	0	0	0	0	0	0	0	0	0
Erairie Archaic (EAR)	0	0	0	3	0	0	0	0	0	0	0	0	0
Woodland (WD)	0	0	0	0	4	0	1	0	0	1	0	0	0
Sonota (SON)	0	0	0	0	0	7	0	1	0	0	1	0	0
Late Woodland (LW)	0	0	0	0	0	0	10	0	1	0	1	1	0
North Blackduck (BDN)	0	0	1	0	0	0	0	13	2	1	1	1	0
South Blackduck (BDS)	0	0	0	1	0	0	0	0	13	1	2	1	0
North Arvilla (NAR)	0	0	0	0	1	0	2	0	1	10	0	2	1
South Arvilla (SAR)	0	0	0	0	0	2	0	0	0	0	19	2	0
Devils Lake Sourisford (DLS)	0	0	0	0	0	0	1	1	0	1	3	8	0
Great Oasis (GRO)	0	0	0	0	0	0	0	0	0	0	0	0	6

Table 4-22 (continued).

Actual Group	PI	PLRP	PAR	EAR	WD	SON	LW	BDN	BDS	NAR	SAR	DLS	GRO
Cambria (CAM)	0	0	0	0	0	0	0	0	0	0	0	0	0
Big Stone (BST)	0	0	1	0	0	0	0	0	0	0	0	0	0
Mill Creek (MCR)	0	0	0	0	0	0	0	0	0	0	0	0	0
Vermillion Bluff (VBL)	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue Earth (BE)	0	0	0	0	0	0	0	0	0	0	1	1	0
Orr (ORR)	0	0	0	0	0	0	0	0	0	0	0	0	0
Silvernale (SIL)	0	0	0	0	0	0	0	0	0	0	0	0	0
Assiniboine (ASB)	0	0	0	0	0	0	0	0	0	0	0	1	0
Cheyenne (CH)	0	0	0	0	0	0	0	0	0	0	0	0	0
Cree (CR)	0	0	0	0	0	0	0	0	0	0	0	0	0
Ojibwa (OJB)	0	0	0	0	0	0	0	0	1	0	0	0	0
Mdewakanton (MDE)	0	0	0	0	0	0	0	0	0	0	0	0	0
Oglala (OGL)	0	0	0	0	0	0	0	0	0	0	0	0	0
Santee (SAN)	0	0	0	0	0	0	0	0	0	0	0	0	0
Sisseton-Wahpeton (SSW)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-22 (continued).

Actual Group	PI	PLRP	PAR	EAR	WD	SON	LW	BDN	BDS	NAR	SAR	DLS	GRO
Teton (TET)	0	0	0	0	0	0	0	0	0	0	0	0	0
Yankton (YKT)	0	0	0	0	0	0	0	0	0	0	0	0	0
Siouan (SX)	0	0	0	0	0	2	0	0	0	0	0	1	0
Winnebago (WIN)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-22 (continued).

Actual Group	CAM	BST	MCR	VBL	BE	ORR	SIL	ASB	CH	CR	OJB	MDE	OGL
Paleoindian (PI)	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelican Rapids (PLRP)	0	0	0	0	0	0	0	0	0	0	0	0	0
Prairie Archaic (PAR)	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Archaic (EAR)	0	0	0	0	0	0	0	0	0	0	0	0	1
Woodland (WD)	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonota (SON)	0	0	0	0	0	0	0	0	0	0	0	0	0
Late Woodland (LW)	0	0	0	0	0	1	0	0	0	0	1	0	0
North Blackduck (BDN)	0	1	0	0	0	1	1	1	0	0	3	0	0
South Blackduck (BDS)	0	0	0	0	0	0	0	0	1	0	0	0	0
North Arvilla (NAR)	0	0	0	0	0	0	0	0	0	0	1	0	0
South Arvilla (SAR)	0	0	0	0	0	0	0	1	0	0	0	0	1
Devils Lake Sourisford (DLS)	0	0	0	0	1	0	0	0	0	0	1	0	0
Great Oasis (GRO)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-22 (continued).

Actual Group	CAM	BST	MCR	VBL	BE	ORR	SIL	ASB	CH	CR	OJB	MDE	OGL
Cambria (CAM)	1	0	0	0	0	0	0	0	0	0	0	0	0
Big Stone (BST)	0	7	0	0	1	10	0	0	0	0	0	0	0
Mill Creek (MCR)	0	0	4	0	0	0	0	0	0	0	0	0	0
Vermillion Bluff (VBL)	0	0	0	1	0	0	0	0	0	0	0	0	0
Blue Earth (BE)	0	0	0	0	6	0	0	0	0	0	0	0	0
Orr (ORR)	0	0	0	0	0	11	0	0	1	0	1	0	0
Silvernale (SIL)	0	0	0	0	0	0	2	0	0	0	0	0	0
Assiniboine (ASB)	0	0	0	0	0	0	0	6	0	0	0	0	0
Cheyenne (CH)	0	0	0	0	0	0	0	0	20	0	0	0	0
Cree (CR)	0	0	0	0	0	0	0	0	0	1	0	0	0
Ojibwa (OJB)	0	0	0	0	1	1	0	0	1	0	10	0	0
Mdewakanton (MDE)	0	0	0	0	0	0	0	0	0	0	0	1	0
Oglala (OGL)	0	0	0	0	0	0	0	0	0	0	1	0	9
Santee (SAN)	0	0	0	0	0	0	0	1	0	0	0	0	1
Sisseton-Wahpeton (SSW)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-22 (continued).

Actual Group	CAM	BST	MCR	VBL	BE	ORR	SIL	ASB	CH	CR	OJB	MDE	OGL
Teton (TET)	0	0	0	0	0	0	0	1	0	0	0	0	0
Yankton (YKT)	0	0	0	0	0	0	0	0	0	0	0	0	0
Siouan (SX)	0	0	0	0	0	1	0	1	0	0	0	0	0
Winnebago (WIN)	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-22 (continued).

Actual Group	SAN	SSW	TET	YKT	SX	WIN	# Mis-identified	N	% Accurate
Paleoindian (PI)	0	0	0	0	0	0	0	1	100.0
Pelican Rapids (PLRP)	0	0	0	0	0	0	0	1	100.0
Prairie Archaic (PAR)	0	0	0	0	0	0	0	3	100.0
Eastern Archaic (EAR)	0	0	0	0	0	0	1	4	75.0
Woodland (WD)	0	0	0	0	0	0	2	6	66.7
Sonota (SON)	0	0	0	0	1	0	3	10	70.0
Late Woodland (LW)	0	0	0	0	0	0	5	15	66.7
North Blackduck (BDN)	0	0	0	0	0	1	14	27	48.01
South Blackduck (BDS)	0	0	0	0	0	0	6	19	68.4
North Arvilla (NAR)	0	0	0	0	1	0	9	19	52.6
South Arvilla (SAR)	0	0	0	0	0	0	6	25	76.0
Devils Lake Sourisford (DLS)	0	1	0	0	2	0	11	19	42.1

Table 4-22 (continued).

Actual Group	SAN	SSW	TET	YKT	SX	WIN	# Mis-identified	N	% Accurate
Great Oasis (GRO)	0	0	0	0	1	0	1	7	85.7
Cambria (CAM)	0	0	0	0	0	0	0	1	100.0
Big Stone (BST)	0	0	0	0	0	0	2	9	77.8
Mill Creek (MCR)	0	0	0	0	0	0	0	4	100.0
Vermillion Bluff (VBL)	0	0	0	0	0	0	0	1	100.0
Blue Earth (BE)	0	0	0	0	0	0	2	8	75
Orr (ORR)	0	0	0	0	0	0	2	13	84.6
Silvernale (SIL)	0	0	0	0	0	0	0	2	100.0
Assiniboine (ASB)	0	0	1	0	0	0	2	8	75.0
Cheyenne (CH)	0	1	0	0	1	0	2	22	90.9
Cree (CR)	0	0	0	0	0	0	0	1	100.0
Ojibwa (OJB)	0	0	0	1	1	0	6	16	62.5
Mdewakanton (MDE)	0	0	0	0	0	0	0	1	100.0
Oglala (OGL)	0	0	0	1	0	0	2	11	81.8

Table 4-22 (continued).

Actual Group	SAN	SSW	TET	YKT	SX	WIN	# Mis-identified	N	% Accurate
Santee (SAN)	7	1	0	0	0	0	3	10	70.0
Sisseton-Wahpeton (SSW)	0	3	0	0	0	0	0	3	100.0
Teton (TET)	0	0	9	0	0	0	1	10	90.0
Yankton (YKT)	0	0	0	4	0	0	0	4	100.0
Siouan (SX)	0	0	1	0	17	0	6	23	73.9
Winnebago (WIN)	0	0	0	0	0	3	0	3	100.0

* 71.9% of original grouped individuals correctly identified as to group of origin

predicted for the same groups identified as such in the previous analyses. Table 4-23 summarizes group prediction results for each comparative analysis. Devils Lake-Sourisford, again presents the lowest percentage (42.1%) of accurate group identification; less than half the Devils Lake-Sourisford individuals are identified as belonging to this complex. As expected, Blackduck-North, followed by Arvilla-North, follow close behind Devils Lake-Sourisford with only a 48.01% and 52.6% accuracy rate, respectively. Similar to the Late Prehistoric - Historic analysis, the Ojibwa represent the most heterogenous historic group as indicated by a low rate of accurate classification.

Table 4-23. Group Prediction Accuracy Percentages Across All Levels of Analysis.

Group	N	Paleoindian, Archaic, Woodland	Late Prehistoric	Late Prehist. / Historic	All Groups
Devils Lake-Sourisford	19	63.2	68.4	42.1	42.1
Blackduck - North	27	77.8	77.8	48.0	48.1
Arvilla - North	19	52.6	63.2	56.9	52.6
Ojibwa	16	Not included	Not included	56.3	62.5
Woodland	6	100.0	Not included	Not included	66.7
Late Woodland	15	93.3	80.0	66.7	66.7
Blackduck- South	19	84.2	73.7	68.4	68.4
Sonota	10	80.0	Not included	Not included	70.0
Santee	10	Not included	Not included	70.0	70.0
Siouan	23	Not included	Not included	82.6	73.9
Eastern Archaic	4	100.0	Not included	Not included	75.0
Blue Earth	8	Not included	75.0	75.0	75.0
Arvilla - South	25	76.0	84.0	84.0	76.0
Big Stone	9	Not included	100.0	88.9	77.8
Oglala	11	Not included	Not included	72.7	81.8
Orr	13	Not included	100.0	69.2	84.6
Great Oasis	7	Not included	100.0	85.7	85.7
Teton	10	Not included	Not included	80.0	90.0
Cheyenne	22	Not included	Not included	95.5	90.9
Paleoindian	1	100.0	Not included	Not included	100.0
Pelican Rapids	1	100.0	Not included	Not included	100.0
Prairie Archaic	3	100.0	Not included	Not included	100.0

Table 4-23 (continued).

Group	N	Paleoindian, Archaic, Woodland	Late Prehistoric	Lat Prehist. / Historic	All Groups
Cambria	1	Not included	100.0	100.0	100.0
Mill Creek	4	Not included	100.0	100.0	100.0
Vermillion Bluff	1	Not included	100.0	100.0	100.0
Silvernale	2	Not included	100.0	100.0	100.0
Cree	1	Not included	Not included	100.0	100.0
Mdewakanton	1	Not included	Not included	100.0	100.0
Sisseton - Wahpeton	3	Not included	Not included	100.0	100.0
Yankton	4	Not included	Not included	100.0	100.0
Winnebago	3	Not included	Not included	100.0	100.0

CHAPTER 5

DISCUSSION

The results of the discriminant function analysis presented here advance our understanding of the population relationships that characterized the approximately 10,000 years of human occupation in Minnesota and border areas in Ontario, Manitoba, North Dakota, South Dakota, Nebraska, and Iowa. The following discussion will focus on the research objectives presented in Chapter 1 with consideration given to some of the gaps in knowledge identified in the summary of the culture history of the study region presented in Chapter 2. Given the broad time-depth of this dissertation, discussion will proceed chronologically from the Early Prehistoric period to the Late Prehistoric-Historic period transition.

The Early Prehistoric Series: Paleoindian, Archaic, and Initial/Early Woodland

The small sample of Early Prehistoric crania places some limits on the type of questions that may reasonably be addressed in this analysis. Research questions formulated for the Archaic Tradition that a biodistance study may provide insight into have centered on: 1) the nature and degree of interaction between the Prairie and Eastern Archaic traditions; 2) the role of *in situ* evolution (continuity) versus migration to explain the appearance of the Paleoindian, Archaic and Initial/Early Woodland manifestations and adaptions; and, 3) evaluation of models exploring the function of Archaic and Initial/Early Woodland burial sites as territorial markers of hunter-gatherer

settlement/subsistence patterns. It is important to note that the interpretations based on the limited sample of Paleoindian, Archaic, and Initial Woodland crania analyzed in the present study must be viewed as tentative with the understanding that sampling error may be a factor in the observed biological distances.

As discussed in Chapter 2, the Early Prehistoric Period in Minnesota is poorly known, primarily due to a paucity of professionally excavated sites. There is, however, intense interest in understanding the genetic history and osteological consequences of the lifestyles of the earliest inhabitants of North America. Not only is the interest academic in nature, but more recently relates to the very real possibility of repatriation as required by the Native American Graves Protection and Repatriation Act (NAGPRA); many of the existing Paleoindian and Archaic skeletons, including those analyzed here, have already been repatriated and reburied as a result of this legislation.

The three oldest skeletons from Minnesota, Browns Valley (21TR05), Pelican Rapids (21OT03), and Sauk Valley (21TO01), have been the focus of intense interest for quite some time (Hrdlička 1937; Jenks 1936, 1937; Kaestle 1997; Nelson 1998; O'Connell and Myster 1996; Powell and Steele 1992; F. Smith 1976; Steele and Powell 1992). Recent Paleoindian research has focused on the nature of the biological relationship between the Paleoindian remains, contemporary American Indians, and other extant populations, particularly South Asian, North Asian, and European (Howells 1989; Powell 1995; Powell and Steele 1992; Steele and Powell 1992). Discussion of the results of a principal components analysis of the Early Prehistoric sample and a sample of world populations from the Howells data set (Howells 1973, 1989) will follow the discussion of

the biodistance analysis of the Minnesota sample.

The results of the principal components analysis of just the Minnesota sample indicate that the single Paleoindian individual, Browns Valley (21TR01), as well as the early Prairie Archaic Pelican Rapids individual (21OT03), are not cranially distinct from the later Archaic and Initial/Early Woodland individuals that comprise the Early Prehistoric Period sample. Certainly each is significantly distant from one or two individuals, however, the overall pattern and relevant statistics suggests that the Early Prehistoric sample is characterized by a significant degree of genetic homogeneity; cranial morphology is not distinctive per each tradition. Two individuals, 21WN15B and 21OT02B, are displaced furthest from the remaining individuals. These two individuals are from the only Eastern Archaic and Initial Woodland sites, respectively, included in this study. The overall morphological similarity indicated by the principal components, however, may be interpreted to indicate that there is genetic continuity between the Paleoindian, Archaic, and Initial/Early Woodland traditions. Cultural evolution occurred through *in situ* development, affected no doubt by developments outside of the study region and subsequent diffusion of ideas, but not by migration of new populations into the region.

Continuity between the Paleoindian and Archaic traditions is indicated by excavations at the stratified, multicomponent Cherokee Sewer site (13CK405), located in northwestern Iowa. A late Paleoindian stratum underlying an Early Archaic stratum was identified at the site. Anderson et al. (1980) note few differences in the activities undertaken during these two occupations. The contribution of the Cherokee Sewer site to

understanding the origins of the Prairie Archaic tradition is significant. Not only does the similarity in lifestyles practiced by Paleoindians and Prairie Archaic peoples at the Cherokee Sewer site require a re-evaluation of the criteria used to distinguish Paleoindian and Archaic adaptations (Benchley et al. 1997:72), but "the settlement and subsistence practices of Prairie Archaic groups represent a direct evolution from the big-game hunting practices of late Pleistocene and early Holocene hunters in the prairie area" (Benchley et al. 1997:85). The biodistance results presented here provide further support for this model by indicating *in situ* evolution of Prairie Archaic populations from earlier Paleoindian populations.

Evidence for the general trends that characterize the Archaic horizon to the south and east of the study region, including increasing regionalization of Archaic communities due to adaptation to major biomes (e.g., prairie, deciduous forest, prairie-lake), focused exploitation of locally available resources, and development of a mobile hunter-gatherer subsistence-settlement adaptation, has been recovered from Archaic sites in Minnesota. Excavations in the Prairie, Prairie Lakes, and Deciduous Forest vegetation zones have identified seasonal resource procurement sites (i.e. bison hunting camps), documented the absence of artifacts manufactured from nonlocal raw materials, and reconstructed subsistence strategies based on local floral and faunal resources (Anfinson 1997; Michlovic 1979; Wilford 1955). It is likely that Prairie Archaic and Eastern Archaic traditions coexisted during the times deciduous forests were present in Minnesota, generally before 7,500 B.P. and after 4,000 B.P., and the results of the biodistance analysis suggest that there is little difference in the cranial morphology of the individuals

representing each tradition. If Voight (21WN15) is an Eastern Archaic site, which is highly likely given that the burials were placed in a naturally formed mound and the burial program is similar to other Archaic sites in Minnesota, the results indicate that there are no significant differences between the two Archaic traditions and, additionally, that continuity extends between two major biomes characterized by prairie and deciduous forest vegetation. Further, if the radiocarbon date for Morrison Mound (21OT02) is accurate (690 B.C.) and this site represents the Initial Woodland, there appears to be no significant shift in cranial morphology throughout the 6,500 year span of the Early Prehistoric cranial series. This may be interpreted as evidence for biological continuity from the Paleoindian tradition throughout the Archaic and into the Initial Woodland. The evidence for continuity is most compelling for the west-central portion of the study region where a majority of the sites are clustered (Browns Valley, Pelican Rapids, Rooney Mound, Clitherall, and Morrison Mound). It is clear from both the principal components and the later discriminant function analyses that the increasing regionalization exhibited by the material culture and resource utilization patterns of these traditions is not mirrored by biological heterogeneity.

The biological homogeneity indicated by these results is consistent with what is known about the patterns of interaction between contemporary hunter-gatherer bands. Keeping in mind Binford's (1967) warnings about the misuse of ethnographic analogy in archaeology, and conceding that the Dobe Ju/'hoansi of the Kalahari desert in southern Africa are not the ideal culture to serve as an analogy to hunter-gatherers adapted to the prairies and deciduous forests of the northern Mississippi River valley, some insight may

be gained from just such a comparison. Contemporary hunting and gathering cultures, as exemplified by the Dobe Ju/'hoansi, tend to practice exogamous marriage - a tradition that results in strengthening interband relationships with the advantage, among other things, of access to different resource regions at various times of the year (cf. Lee 1993). Such marriage practices would facilitate significant and continual gene flow with the end result of decreased genetic (and phenotypic) variability between groups (Meiklejohn 1972). This is one possible scenario to explain the biological homogeneity and continuity exhibited by the earliest prehistoric populations in the study region.

Further comments are warranted regarding the broader implications of the absence of any biological distinction between Voight (21WN15) and Morrison Mounds (21OT02), as representative of the Initial/Early Woodland in Minnesota, and the earlier Archaic and Paleoindian individuals. The Late Archaic- Early Woodland transition in the Upper Midwest has been an area of considerable interest and frustration for a number of years (Bozhardt et al. 1986; Farnsworth and Emerson 1986; Gibbon 1986; Griffin 1986), but has received more focused attention recently (Hohman-Caine and Goltz 1995). Discussions have centered around the existence of an Early Woodland pattern of adaptation as defined by cultural manifestations to the south and east of the Upper Mississippi River Valley. Until more recently, the general consensus was that an Early Woodland period in Minnesota did not exist (Gibbon 1986). However, work dating the early appearance of Brainerd Ware ceramics, defining its temporal and geographic range of occurrence "has strained the existing paradigm of the Early Woodland in Minnesota" (Hohman-Caine and Goltz 1995:109). Hohman-Caine and Goltz report and discuss the

implications for 18 radiometric dates from nine sites where Brainerd Ware ceramics have been recovered. These 18 dates indicate that the temporal range for Brainerd Ware ceramics begins as early as 1,430 B.C. and extends in time to A.D. 535. Dates cluster around approximately 800 B.C. and, less so, around 400 B.C.. Additionally, Hohman-Caine and Goltz propose a new cultural manifestation, Elk Lake Culture, characterized by Brainerd Ware ceramics, exploitation of "the prairie/woodland ecotone" and continuation of a "basic Archaic lifestyle" (Hohman-Caine and Goltz 1995:127). The existence of an archaeological culture that exhibits a mosaic of traditionally Archaic and traditionally Woodland characteristics more accurately reflects the complexity of human adaptations during periods of transition between major cultural shifts (recall Anderson et al. 1980 re. the Paleoindian and Prairie Archaic interface). Both Voight (21WN15) and Morrison Mounds (21OT02) yielded radiocarbon dates that fall in the transition period between the Late Archaic and Early Woodland. Voight is very likely an Archaic site as it is characterized by Archaic-like features including burial in a naturally formed mound, the absence of ceramics, worked bone, stone and shell artifacts, and unworked copper pieces (Fiske and Hume 1963). The classification of Morrison Mounds is more confounding. Materials recovered from the fill include shell fragments, fragmented faunal remains (including a distal bison radius), chert and quartzite flakes, two grit-tempered ceramic sherds, two knives (bluff chert), broken projectile point (white chert), drill (quartz), worked flake (buff chert), three end scrapers (white chert, gray chert, chalcedony), and an irregular fragment of white chert (Wilford 1970:25). Burials, both secondary and primary, were generally placed in shallow subfloor pits. Two mounds

contained evidence of burnt logs arranged over the central burial pit. The radiocarbon date of 690 B.C. has been questioned due to possible "atmospheric contamination" from open drawer storage and the fact that only a single sample was dated (Johnson 1964; Anfinson 1979:15). Much of the unwillingness to accept this date, from the perspective of this author, is that it represents a very early date for the first construction of earthen burial mounds. Considering the potential for very early dates for ceramic manufacture (ca. 1430 B.C.) in north-central Minnesota (Hohman-Caine and Goltz 1995), it may be time to consider that mound construction may also have been practiced earlier than previously believed. The lack of differentiation of these two sites in the biological distance analysis certainly argues at least for the idea that the transition from the Late Archaic to the Early/Initial Woodland was characterized by *in situ* development and ceramic manufacturing techniques and earthen mound construction and burial were practices adopted through cultural diffusion.

The final question to be addressed relates to the function of burial sites during the Archaic. It has been proposed that Archaic burial sites were situated to demarcate inherited hunter-gatherer territories and may have been systematically re-used by members of a particular lineage through time (Benn et al. 1992). The biological homogeneity indicated by the results appears to contradict this interpretation. However, further analyses, comparing the cranial morphology of males and females and possibly indicating marriage practices, may provide additional insight and clarification into this question

As stated earlier, much of the current interest in the Paleoindian period has focused

on the genetic relationships between Paleoindians, contemporary American Indian tribes, and more distant populations from various parts of the world in a search for the Old World ancestors of the Paleoindians and the evaluation of models put forth to explain the peopling of the New World. Most researchers conclude that the Paleoindians are, in fact, morphologically distinct "from their late-Holocene descendants in the New World. Previous univariate and bivariate analyses conclude that Paleoindians fall at one extreme of the American Indian craniometric range, away from northern Asians, and nearer to southern Asians and Europeans" (Powell and Steele 1992:60). A review of Figure 4-3 illustrates that a similar pattern characterizes the relationship between the Early Prehistoric sample from Minnesota with one distinction, the Early Prehistoric sample, including the Paleoindian individual from Browns Valley, and the early Prairie Archaic Pelican Rapids individual, are situated in two distinct clusters as defined by PC 2. The cluster containing Browns Valley falls closer to the Polynesian Moriori and Eskimo, while the cluster containing Pelican Rapids is closer to the North American Blackfeet and Sioux. Interestingly, the Blackfeet and Sioux are hypothesized to have been in the vicinity of the study region prior to European contact.

Early to Middle Prehistoric Period Transition

Discussion of the discriminant function analysis of the Paleoindian, Archaic, and Woodland series will address the biological effects of the cultural transition from the Early Prehistoric period to the Woodland period, evidence for widespread genetic interaction between Woodland populations, evidence for localized adaptation and, possibly, more limited genetic interaction, and the hetero- versus homogeneity of cranial

morphology of the Woodland groups.

An understanding of the transition from the Archaic to the Woodland tradition remains elusive for Minnesota and the results of the current analysis do little to clarify this important period. There are, overall, very few archaeological sites from this time period (Anfinson 1997; Benchley et al. 1997) and even fewer mortuary sites (Myster and O'Connell 1997). Table 2-3 lists the archaeological contexts for Minnesota portion of the study region and clearly illustrates the limitation in the study sample to address the Archaic-Woodland transition. Only two contexts for the earlier portion of the Woodland period, Sonota and a generalized "Woodland" sample comprised of Morrison's Mound and several unclassified Woodland sites, are represented by human cranial remains. Nevertheless, some intriguing patterns emerged as a result of this group analysis. There appears to be three primary clusters defined taxonomically by tradition. The anomaly is the association of the Late Woodland North Blackduck sample with the Archaic groups. The North Blackduck sample remains an outlier to the other Woodland groups in all subsequent analyses. The Archaic cluster is loosely associated and the significant distance between the Eastern Archaic and Prairie Archaic samples likely reflects the cultural and temporal differences that characterize these two traditions (Anfinson 1987). The notable separation between the Archaic cluster and the Woodland sites may reflect two possible situations, both of which reflect the limitations of this sample. First, it may be representative of the temporal "distance" between the groups. I consider this to be an unlikely explanation, however, due to the fact that most of the Archaic sample is comprised of widely distributed Archaic sites biased toward the Late Archaic and the

Woodland sample consists of the Middle Woodland Sonota and the transitional Arvilla groups. A second and more likely interpretation is that there is not whole-sale genetic continuity between the Archaic and Woodland groups. The Eastern Archaic sample from the Voight site (21WN15) may very well find its closest affinity to be with the more eastern Early/Middle Woodland groups in Minnesota, including Howard Lake (situated in just north of the present-day Twin Cities), Wisconsin, or Iowa (Ryan Phase) that also reflect a deciduous forest adaptation. None of these phases have yielded significant skeletal samples (Myster and O'Connell 1997), therefore, this hypothesis must remain speculative at this point. The Prairie Archaic group is situated some distance from the Woodland cluster; this indicates genetic discontinuity. The somewhat isolated position of the Prairie Archaic sample likely reflects the lack of any individuals from Prairie Lake region's Terminal Archaic (Mountain Lake) and Middle Woodland (Fox Lake and Lake Benton) phases. Given the overall environmental stability of the Prairie and southwestern Prairie Lakes region during this time and absence of evidence for migration into the region during the Middle Prehistoric period, I expect that individuals from these phases would cluster close to the Archaic sites due to geographic and temporal proximity.

With the addition of the Woodland sample, Browns Valley is displaced from both the Archaic and Woodland groups and the "Woodland" group from the Archaic sample. The addition of other, unclassified, Woodland crania to the Morrisons Mound sample resulted in its displacement due, more than likely, to a sample with no biological cohesion. The isolation of the Browns Valley individual is interesting and suggests less

genetic continuity with later Woodland groups. This may be indicative of migration of some of the later Woodland populations into the region or just the absence of more geographically proximate groups.

The Woodland groups form a tighter cluster along the second discriminant function and reflect, to a degree, an east to west geographic continuum. Those groups located in the prairie zone to the west of the mixed deciduous/coniferous forest environment (Sonota, South Arvilla, North Arvilla, and Devils Lake - Sourisford) form a small cluster within the larger Woodland cluster, slightly displaced from the remaining Woodland groups adapted to a deciduous forest biome. The significance of this pattern will be discussed below in the **Late Prehistoric Series** section.

Late Prehistoric Series

Southern Portion of Study Region

The southern portion of Minnesota, and to a degree, the larger study region was host to four distinct archaeological traditions (Woodland, Oneota, Plains Village, Mississippian) during the late Prehistoric period. These four traditions coexisted for much of their temporal ranges (see Table 2-3 for a summary of the temporal ranges for each group). The more dense population sizes and geographic proximity of these manifestations to one another certainly contributed to the dynamic nature of the period The early part of the late prehistoric period "witnessed a series of gradual but profound cultural changes. Among the most important of these were: an increase in numbers of camps, villages, and burial mounds; tighter packing of populations resulting in territory allocations; a spread of populations into more varied environments and greater

exploitation of upland resources; the development of significant regional differences in local group size and complexity; an increase in sedentism in some areas; increasing dependence on cultivated starchy and oil seed plants, including maize ..." (Gibbon 1994:130). Overviews of this period are numerous and informative about areal culture histories, competing transformation models, and syntheses of the current state of knowledge (Anfinson 1987; Benn 1989; Gibbon 1994; Green 1986, 1995). Discussion of the biological distance results will focus on the genetic relationship within and between the four traditions.

Significant gaps in our understanding of the Middle Missouri tradition of the Plains Village pattern persist and much archaeological research has been directed toward clarifying the origins, development, fate, and culture history of this widespread and long-standing complex (D. Anderson 1969, 1987; Anfinson 1987, 1997; Blakeslee 1994; Caldwell 1966; Gibbon 1993; Henning 1971; 1989; Johnson 1971, 1991; Lehmer 1971a, 1971b; Strong 1940; Tiffany 1983; Wilford 1945b, 1955; Will and Hecker 1944). Biological anthropologists have entered the discussions as well and have provided some clarification of the biological relationships between groups (Jantz 1977; Key 1983, 1994; Owsley et al. 1981).

Four phases of the Initial variant of the Middle Missouri tradition (IMM) were analyzed in the present study, Great Oasis (variously considered as either a Woodland or an Initial Variant phase), Mill Creek, Cambria, and Big Stone. The results of the discriminant function analysis relative to this group provides insight into questions relating to the origins, patterns of interaction with neighboring groups, and the ultimate

disappearance of the IMM groups present in Minnesota. Firm conclusions, however, remain elusive due to small sample sizes, particularly of the IMM phases. Relevant scatterplots and tables are presented in Chapter 4 (Figures 4-5 through 4-8, Tables 4-11 through 4-23).

The patterns illustrated by the scatterplots suggest several important relationships to consider. To summarize, the IMM groups including Great Oasis, cluster with the Oneota and Mississippian groups from Minnesota (Figure 4-5). Within this IMM group, Mill Creek and Great Oasis are displaced from the other IMM groups along DF 2. The larger IMM-Oneota-Mississippian group is displaced from a very tight cluster of Woodland groups that occupied the Northern/Northeastern Plains and Northwestern Woodlands and include North Arvilla, South Arvilla, Devils Lake-Sourisford, South Blackduck, and an unspecified Late Woodland group. The North Blackduck group is positioned between these two clusters. The Big Stone phase forms a close cluster with Cambria, the Oneota Orr, and Mississippian Silvernale phases.

The position of Great Oasis *vis a vis* the Late Woodland groups indicates genetic discontinuity with the sample of late Northern Plains Woodland phases; it clearly shows greater affinity to Initial variant and Oneota phases. Additionally, genetic discontinuity with Middle Woodland (or Plains Woodland) groups, including Sonota and an unclassified, general "Woodland" sample, is suggested by a discriminant function analysis of the entire prehistoric sample (Myster 2000). Together, these analyses suggest that Great Oasis is not biologically affiliated with any of the Middle and Late Woodland groups of the Northern Plains and, therefore, the Woodland influence seen in its material

culture (i.e. single cord-impressed pottery) does not result from a Northern Plains Woodland source or ancestry. Great Oasis does cluster most closely, however, with the Mill Creek phase sample of the IMM suggesting some degree of biological interaction. Taken at face-value, the results may be interpreted as biological support for taxonomic classification of Great Oasis as one of the early phases of the IMM (Caldwell and Henning 1978; Henning 1988, 1989; Henning and Henning 1978) while leaving the door open for a southwestern Minnesota and northwestern Iowa origin for the Middle Missouri tradition (Hurt 1951, 1953; Lehmer 1971b). Such a conclusion, however, would be premature given the limited Middle Woodland samples from the study region, particularly those from southwestern Minnesota.

Fortunately, clarification and more definitive conclusions are possible with the integration of the results from the current study with Key's (1994) most recent analysis of intergroup relationships during the Woodland period in the Northern Plains. Key's (1994) biodistance analysis suggests that there is biological continuity between Middle Woodland groups from the Central Plains (e.g., Valley and Keith complexes) and Great Oasis and Mill Creek populations. Considering the significant distance between the Middle Woodland Sonota and transitional Arvilla complexes and Great Oasis (also suggested by Key's results), it may be concluded that the origins of the Middle Missouri tradition are to be found during the Middle Woodland in the Central Plains area. A Woodland ancestral base, with some degree of participation by Great Oasis, for the Middle Missouri tradition has been postulated by numerous archaeologists (Alex 1981; D. Anderson 1981, 1987; Henning 1967, 1971a, 1991; Johnson1986; Johnston 1967;

Tiffany 1983). This opinion, however, was most strongly championed by Henning who, in 1971 stated that "Additionally, Great Oasis may offer an ancestral tie between late Woodland manifestations and Mill Creek. The data offered by Johnston (1967) are vital to consideration of a relationship between Woodland, Great Oasis and Initial Middle Missouri on the Missouri Mainstem" (1971a:9). Additionally, the results reported here provide the biological data necessary to finally lay to rest the hypotheses put forth much earlier by Griffin (1946, 1960), Ives (1962), and others, that Mill Creek evolved from a Mississippian base located in east-central Minnesota. As discussed in Chapter 2, interpretation of the material remains recovered from Mill Creek sites indicate the same conclusion (Tiffany 1983).

The smaller cluster of Cambria, Big Stone, Orr and Silvernale is indicative of some degree of genetic interaction. The genetic proximity of these groups is interesting given the hypothesized replacement of IMM groups by the Oneota circa AD1200/1300 by "possibly driving Initial variant cultures westward" (Gibbon 1994:182). Archaeologists have interpreted the presence of large fortified village sites in this region as part of a strategy of defense against the incursion of neighboring groups. Preliminary skeletal analyses of Oneota and IMM sites does not support the presence of chronic or sporadic warfare between groups; very few skeletons exhibit traumatic injuries indicative of warfare (see Jahnke, 1998, for an analysis of Big Stone phase sites). Additionally, the genetic similarity between the groups is suggestive of some form of mate exchange.

The looser clustering of the Oneota, Big Stone, Cambria, and Silvernale, may also be related to the location of the Big Stone phase communities around Big Stone Lake. "The

Lake Traverse-Big Stone Lake area seems to have been a major interaction zone among native inhabitants during the period immediately before white contact" (Anfinson 1997:119). Such a major "interaction zone" would certainly result in numerous opportunities to exchange not only goods and resources, but mates.

Evidence for the interaction between Oneota, IMM, and Mississippian groups is present in the archaeological assemblages of each group. Cambria phase sites, for example, exhibit influences from Middle Missouri, Oneota, and even Woodland traditions (Gibbon 1991; Johnson 1986). Further, Cambria ceramic sherds have been found in Blue Earth Oneota sites and Silvernale occupations in the Red Wing locale. The biological distance analysis presented here suggests biological interaction between Cambria, Big Stone, Oneota, and Mississippian groups in the vicinity, but not with local Woodland groups. This conclusion contradicts that presented by Johnson (1991:316) who concludes, "In summary, it is clear that Cambria developed in place from a Woodland population. I suggest that Cambria phase riverine and uplands sites of the upper Minnesota River watershed form an exchange subset in a larger-based Cahokia network...." Related to the interpretation of the biological affinities of Cambria, are the associations of the related Big Stone phase. Recall that the designation of Big Stone is relatively recent (Anfinson 1987, 1997; Haug 1983) and reflects the belief by these two researchers that the settlement patterns, subsistence practices, and ceramic features are significantly distinct from Cambria to warrant classification into a separate phase. Big Stone is part of the tight cluster comprised of Cambria, Orr, and Silvernale with looser ties to Blue Earth, Great Oasis, and Mill Creek. The proximity of Big Stone to Cambria

indicates a significant degree of genetic relatedness, but does not clarify whether these two samples come from two distinct, but related, populations. Recall, as well, that the Cambria sample consists of a single individual. Of greater interest, I believe, is the distinct clustering of the whole group from the local Woodland manifestations. The separation of the two groups indicate significant genetic discontinuity, suggesting migration into the region of one of the clusters, most likely the Oneota, Silvernale, and Middle Missouri tradition populations (also indicated by earlier discussion) and little subsequent biological interaction between what is essentially the northern and southern halves of the study region.

Distinct clustering of the Woodland and the Oneota-MMT-Silvernale groups does not mean that the nonWoodland groups migrated together, but rather developed from a separate ancestral base or, more likely, bases, than the Late Woodland Arvilla, Devils Lake - Sourisford, and Blackduck groups. It is very likely that the more similar lifestyles practiced by the Oneota, Silvernale and Middle Missouri groups, characterized by a greater degree of sedentism, more intensive reliance on maize, adoption of different technology, and participation in extensive trade-networks emanating from Cahokia resulted in a greater degree of biological interaction in addition to cultural interaction. Site-unit intrusion of a Middle Mississippian population is unlikely (Gibbon 1991). Gibbon (1991:220) further reports that Oneota and Oneota-Middle Mississippian blended artifacts and structures dominate the artifact assemblage of the Mississippian Silvernale phase sites.

The displacement of Great Oasis and Mill Creek phase samples from the Big Stone-

Cambria-Oneota Orr-Silvernale cluster may be indicative of their geographic distance to the south and west and their greater affinities to the Central Plains Middle Woodland groups (Key 1994) and even later Central Plains proto-historic and historic tribes such as the Arikara (Owsley et al. 1981).

The genetic discontinuity between the Arvilla samples, both south and north, and the IMM groups, particularly Big Stone, is of interest and, given that they directly precede the appearance of the Initial variant groups in precisely the same vicinity as Big Stone/Cambria, is further evidence that the origins of the IMM are not to be found in the Middle/Late Woodland populations situated in the Northern and Northeastern Plains. Key (1994) suggests that the discontinuity indicated by his results between the Northern Late Woodland groups and the Central Plains groups may indicate that the Late Woodland groups situated in the Northern Plains are recent migrants to the region. This interpretation receives some support and is exemplified by the close affinity indicated between the southern Blackduck group situated in central MN (deciduous forest) and Devils Lake - Sourisford, North Arvilla, and South Arvilla groups that, though situated in the Northeastern portion of the Plains, carry strong indication of Woodland adaptations (Gregg 1994). The results presented here may indicate that the Late Woodland Northern Plains groups originated in present-day Minnesota; an idea put forth 60 years ago by Strong (1940) and, even earlier by Swanton (1930).

The Oneota groups do not form a tight cluster when their centroids are plotted along the first two discriminant functions. Vermillion Bluff (VBL) is displaced from all Late Prehistoric groups, including the other Oneota groups. This is not surprising given its

significant geographic distance south and west of the Minnesota sample. Orr and Blue Earth comprise part of the Cambria, Big Stone, and Silvernale cluster; Blue Earth is situation in between this cluster and that of the Late Woodland groups. As discussed earlier this may indicate widespread population movements and potential mate exchange during this time. The Oneota groups associate more closely with the Plains Village groups than with the Late Woodland groups included in the analysis, reflecting, as suggested earlier, an appreciable degree of biological interaction. Oneota interaction with Late Woodland groups represented in the study sample, particularly Orr, indicates little interaction. Blue Earth, however, is situated closer to the Late Woodland groups, particularly Devils Lake - Sourisford and South Arvilla. This arrangement is suggestive of some degree of biological interaction. There is temporal disparity between Blue Earth (A.D. 1,000 - 1670) and South Arvilla (A.D. 500/600 - 900) that complicates and seems to negate this interpretation. Devils Lake - Sourisford, however, dated between A.D. 900 - 1,400, may reflect biological interaction. Interestingly, there is archaeological evidence, in the form of pottery sherds and vessels, that is suggestive of Oneota contact and/or trade in the Northwestern Plains. "To the west on the prairies of northwestern Minnesota, eastern North Dakota, and southern Manitoba, Oneota pottery is extensive but also present in only small amounts" (Gibbon 1995:184).

Gibbon (1995) promotes new directions for Oneota research that center on documenting and explaining the presence of Oneota ceramics beyond what is typically considered the "Oneota homeland", into the Northeastern Plains and the north-central woodlands of Minnesota. Three models are presented that offer new perspectives on the

interpretation of the "external exchange relations." Any practice of trade/exchange has implications for biological relationships between groups and, therefore, these models may also offer insight into the results presented here. The Trade Systems Model addresses exchange at three levels, internal (within village or social groups), local (occurs between unrelated neighboring tribes or ethnic groups), and external (participation in long-distance trade through more formally organized rendezvous or multi-group gatherings). Local and external are most relevant to the results presented here. Reasons for exchange according to this model include enhancing access to varied resource zones and the formation of alliances to maintain or promote the status of certain kin groups. The advantages of such exchanges are frequently attained through the arranging of marriages - usually the exchange of women. The Network Building and Political Power Model presents a more expansionist and entrepreneurial perspective and "focuses on the dynamics of social relations and social production within the context of regional alliance formation and exchange (Bailey 1969; Barnes 1969; Bender 1979, 1985; Hindess and Hirst 1975; Howard and Skinner 1984; Mitchell 1969; Nassaney 1987; Saitta 1983)" (Gibbon 1995:178). Marriage exchange is a likely component in this model, as well. The Ethnic Boundaries and Ethnic Styles Model is expressed more in a postmodernist perspective that challenges traditional ideas of ethnic identity and bounded social aggregates. Of these three models, I believe the Trade Systems model offers the best explanation of the relationships suggested by the current results and what we know biologically about the relevant populations. Much more extensive research must be conducted, however, to say definitively which, if any, of these models best represents

what occurred during the Late Prehistoric Period in the study region. Gibbon (1995:190) suggests possible sources of evidence to support such a model. Among other things, these include, the identification of "central exchange centers in the trading network ... and attempt to systematically determine what passed through the exchange system, ..." One central exchange center could have been the vicinity of Big Stone Lake and Lake Traverse, an area identified as just such a locale where many groups gathered to trade in protohistoric and historic times (Anfinson 1997). Whereas no systematic study of what material remains may be exchanged goods has been undertaken, we do know that various foodstuffs not locally available to groups in different ecological zones have been exchanged including ceramics, wild rice and maize (Jahnke 2000, Johnson 1991). Additionally, analyses of human remains representing Blackduck, North Arvilla, Big Stone, and Blue Earth and Orr Oneota indicate little evidence of nutritional deficiencies suggesting a varied diet that provided adequate nutrients (W. Anderson 1963; Blue 1996a, 1996b; Jahnke 1998; Kimmerle 1997; unpublished data on file at the Hamline University Osteology Laboratory). The Network Building and Political Power Model suggests a more aggressive expansion, and whereas there is the appearance of fortifications at numerous sites, there is little evidence of any interpersonal violence on the human remains from the relevant phases (Myster and O'Connell 1997). Regardless of the preliminary interpretations presented here, the models presented by Gibbon (1995) offer exciting possibilities for future research into the extent and consequence, both biological and cultural, of the external exchange relationships of the Oneota.

Northern Portion of Study Region

The northern portion of the study region also experienced significant changes during the Late Prehistoric Period. These changes were related and symbiotic with those occurring in the southern portion of the study region. Gibbon (1994), Syms (1977), and others (see Benchley et al. 1997 for an overview) summarize these changes. Most significant to the understanding of population relationships and the nature of group interaction are the documented increase in population as indicated by more and larger sites, a trend toward increasing sedentism in some groups and a continuation of a more nomadic hunter and gatherer settlement/subsistence pattern in others, a shift in internal socio-political organization toward greater complexity, an increase in burial mounds, greater exploitation and reliance on wild rice (facilitated many of the previously listed adaptations), and increased interaction between groups in order to exchange foodstuffs, technological innovations, and/or trade goods. Populations practicing a Woodland lifestyle predominated within the northern portion of the study region; sites indicating predominant occupations of the Oneota, Middle Missouri, and Mississippian traditions have not been found in the northern reaches of the study region.

The emphasis of the following discussion will focus on key issues identified for the Blackduck, Arvilla, and Devils Lake-Sourisford manifestations. Key questions will address the origins and genetic homogeneity of each manifestation, as well as the nature of the interaction among the groups, as well as with the populations located in the southern reaches of the study region.

As mentioned previously, a majority of the late Woodland groups cluster together in

the Late Prehistoric and Late Prehistoric-Historic analyses (see Figures 4-5 and 4-6). The exception is the North Blackduck group comprised of crania recovered from mounds along the Rainy River and Ontario. The significant displacement between the two Blackduck samples is not surprising given the results of Ossenberg's (1974) biodistance study of Late Woodland populations in the Upper Midwest, Kolar's (1982) analysis of Hungry Hall Mounds 1 and 2, and previous research on Blackduck material culture, primarily ceramics (Evans 1961b; Lugenbeal 1976; Thomas and Mather 1996). It is the consensus that the Blackduck Configuration (see Thomas and Mather 1996) represents two distinct groups, one centered in north-central Minnesota in the region of the headwaters of the Mississippi river and the other situated in northern Minnesota and adjacent areas of Ontario. It has also been suggested that McKinstry Mound 2 may represent a population that postdates the Middle Woodland Laurel occupation but is not Blackduck (Stoltman 1973). If this were the case, 12 of 33 individuals (36%) currently classified as "North Blackduck" would need to be removed from this category; their genetic influence in a sample of 33 would be significant and enough to cause significant genetic heterogeneity.

The biodistance analyses of both Kolar (1982) and Ossenberg (1974) are based on cranial nonmetric traits. Each conclude that the northern Blackduck group is distinct from the southern Blackduck and that the northern group shares close affinities to their North Arvilla sample. Ossenberg (1974) further concludes that the northern Blackduck are more closely related to other groups, such as Arvilla, Devils Lake-Sourisford, and Mille Lacs Kathio, than the southern Blackduck. This situation was interpreted as

indicating that the northern Blackduck may have migrated more widely during the annual subsistence round. Whereas the results presented here support the existence of two distinct groups, my results indicate biological affinities opposite those of Ossenberg (1974): the southern Blackduck exhibit closer affinities to the other Late Woodland groups while the northern Blackduck are somewhat displaced from the other groups. It should be noted that since Ossenberg's pioneering study significant reclassification of Blackduck (Ossenberg's Manitoba Focus as defined by MacNeish 1954, 1958 and Vickers 1947), Arvilla, and Devils Lake - Sourisford sites has occurred (Syms 1978, 1979, 1982) with the end result that my northern Blackduck, Arvilla and Devils Lake - Sourisford cranial samples bear little resemblance to Ossenberg's (1974). This reorganization significantly impacts the biological distances indicated by the current discriminant function analysis and the overall interpretation of Late Woodland population relationships in the Upper Midwest.

The close biological relationships between the southern Blackduck and Late Woodland samples, as well as the Late Woodland groups from the Northeastern Plains, suggests a close genetic relationship and the possibility that these groups may have had their origin in the region of Minnesota and, sometime later, migrated west. As mentioned previously, this interpretation is well supported by the results presented by Key (1994) that illustrate genetic discontinuity between the Late Woodland groups of the Northwestern Plains and Middle Woodland groups in the Central Plains region.

As described in Chapter 2, Blackduck sites are distributed widely and are found in an area from the northern third of Minnesota and northwest Ontario, north and east through

Manitoba with its most western extension into eastern Saskatchewan. They were the dominant archaeological manifestation during the period A.D. 900 - 1200, superceding the Middle Woodland Laurel in many areas. A paucity of radiocarbon dates has frustrated attempts to reconstruct the processes involved in the appearance/origin of this phase and the pattern and nature of its diffusion throughout such a large region.

Key research questions formulated to facilitate a more sophisticated and in-depth understanding of the Blackduck manifestations focus on evidence for the origins of this archaeological construct, nature and patterns of adaptation to the local physical environments (e.g., Plains, Boreal Forest, Aspen Parkland, Coniferous Forest), patterns of biological and cultural interaction with neighboring human groups, including other Blackduck and non-Blackduck communities, and, the identification of the most likely descendant ethnic group(s).

A question of great relevance and one that, unfortunately, must remain open, at least from a cranial metric perspective, is that of the origins of the Blackduck, or more precisely, Blackduck ceramics. Meyer and Hamilton (1994:117) state "... it appears likely that Blackduck took form in the Boundary Waters area." From whom they evolved, however, is unclear. Many researchers (Buchner 1979, 1982; Dawson 1974; Evans 1961b; Gibbon 1994) argue that Blackduck evolved from directly from Laurel. Others, notably Hlady (1970) and Syms (1977), do not believe that the evidence supports *in situ* development. Lugenbeal (1976), based on his exhaustive and thorough analysis of Laurel and Blackduck ceramics, concluded that although the evidence is not compelling, it can be used to support a direct development of Blackduck from Laurel. Ossenberg

(1974) suggests that an ancestor-descendant relationship for Laurel and Blackduck is indicated by her results. Although the largest Laurel mortuary site, Smith Mounds (21KC03), is located in Minnesota, 205 of 206 individuals recovered from two of the four mounds were reburied prior to collection of any cranial metric and dental nonmetric data. The cranium of a single adult female was measured prior to reburial. In all preliminary discriminant function analyses she was situated as an extreme outlier relative to all cranial samples analyzed.. Due to what appeared to be an anomalous morphology, she was removed from the final multivariate analyses and no assessment of biological continuity between Blackduck and Laurel can be presented.

The Late Woodland groups of the northern portion of the study region are characterized by significant genetic heterogeneity as indicated by the accuracy with which the group of origin is predicted for each individual (see Tables 4-14, 4-18, 4-22, 4-23). Those with the most accurate group membership prediction were the southern horticultural groups including Mill Creek, Great Oasis, Orr and Blue Earth Oneota, and Big Stone. It is notable that two of the three groups characterized by the poorest group membership predictability - Arvilla and Devils Lake Sourisford - and therefore, significant genetic heterogeneity, are burial complexes as opposed to archaeological phases. The phase, as a taxonomic unit, exhibits some cohesiveness. It is spatially and chronologically delimited and is differentiated from other phases by a distinct combination of artifactual and behavioral traits (Willey and Phillips 1962:22). Conversely, a burial complex is characterized by a more loose association of traits and the absence of any clear cultural characteristics indicative of a broader cultural system.

Burial complexes are identified, in part, by spatial and temporal boundaries. However, the artifactual and behavior traits are not as clearly defined primarily due to the absence of associated habitation or other nonmortuary special function sites (Syms 1977, 1982). The definition and site composition of both the Arvilla Complex and the Devils Lake - Sourisford Complex have been the subject of much research and discussion (Johnson 1973; Michlovic 1982; Anderson 1963; Ossenberg 1974; Syms 1977, 1979, 1982.). It is generally agreed, however, that both burial complexes most likely represent a cross-section of individuals from many populations rather than a more culturally and, theoretically, biologically homogenous phase.

The artifacts recovered from sites identified for each of these complexes indicates interaction with numerous other traditions. The nature of the interaction, however, between the various other groups is unknown. Shared traits between Devils Lake - Sourisford and Arvilla indicate contact and include: short columella and *Dentalium* beads; *Natica,* washer-shaped, and notched trapezoidal shell beads; bone beads; bone bracelets; and, small globular pots (Johnson 1973; Syms 1979, 1982). Mississippian influence is significant and suggested by ceramic decoration that is incised on mostly smooth surfaces, incised tablet, the presence of lizard/salamander and "weeping-eye" motifs, and pottery characterized by handles (Syms 1979). Less definitive, but suggestive, contact is indicated between Devils Lake - Sourisford and the Initial and Extended Middle Missouri groups to the south and east by similarities in side-notched projectile points and ceramic techniques ("cord-impressed braced rim and smoothed-over, simple stamped") and the presence of columella beads and pendants (Syms

1979:298). Contact between Blackduck and Arvilla is indicated by the presence of a miniature/"mortuary" Blackduck vessel and unilateral barbed harpoons. A Late Woodland Kathio phase vessel was also recovered in association with an Arvilla burial (Johnson 1973). Certainly the similarities listed above indicate participation in similar trade networks, however, the results presented here indicate significant biological relationships between Devils Lake - Sourisford, Arvilla, Blackduck, and the general Late Woodland group and biological discontinuity with the Initial variant Middle Missouri and Mississippian groups included in this study.

An alternative explanation of the poor group classification accuracy is that the Arvilla, Devils Lake - Sourisford, and Blackduck groups reflect the biological consequences of a "hunting and gathering subsistence base with seasonal movement between resource zones" (Gibbon 1994:144) believed to characterize, in particular, the Blackduck. Extensive evidence for seasonal migration between different biomes for the other Late Woodland groups is presented by Syms (1977, 1979, 1982). There is, further, evidence to suggest that small Blackduck resource procurement sites in different resource zones may have "served primarily as 'exchange centers' where small numbers of people from two or more social groups met to exchange goods and information" (Gibbon 1994:144). It does not take a great leap of faith to consider the potential for marriage exchanges, as well as resources, at these meetings. Such marriage arrangements would result in continued access to varied subsistence and material resources, interband alliances (perhaps important with the documented population increases and localized "population packing" in the Late Woodland), and exchange of manufacturing

technologies and stylistic innovations. As detailed above, the presence of "foreign" artifacts have been recovered from Arvilla and Devils Lake - Sourisford burials (Johnson 1973; Syms 1982). Continual marriage exchanges between groups would result in decreased intergroup heterogeneity coupled with increased intragroup heterogeneity; the low percentage of correct group classification may reflect such a practice.

When considering the classification and biological distance results of the Late Prehistoric analysis, significantly different patterns of social integration and network/"alliance" formation throughout the study region are indicated. These patterns reflect distinctive adaptations to local environmental and cultural landscapes during a period of wide-ranging changes in population size, subsistence practices, and socio-political organization. Tribalization models (Gibbon 1989) that recognize the development of a tribal social network within a hunter-gatherer settlement-subsistence lifestyle offer a reasonable explanation for the patterns of population relationships and the biological cohesiveness identified. It is also important to recognize, as the archaeological record indicates with evidence of contact and interaction, that the Late Prehistoric hunter-gatherers of the northern portion of the study region did not live in isolation from the more complexly organized horticultural groups in the south. There were complex trade networks that diffused technological, stylistic, and social practices throughout a vast area including the Northeastern Plains, the western Eastern Woodlands, and the Upper Great Lakes regions.

Late Prehistoric - Historic Period Relationships

The attempt to link prehistoric archaeological manifestations with ethnohistoric

tribal groups has often been attempted and most results and interpretations have met with varying degrees of criticism (for example, Bishop and Smith 1975; Dawson 1976; Evans 1961a, 1961b; Hlady 1952, 1970; Johnson 1969; MacNeish 1958; Michlovic 1977; Obey 1974; Ossenberg 1974; Overstreet 1995; Steinbring 1980; Syms 1977, 1979; Vickers 1948; M. Wedel 1986; Wilford 1937a, 1955; Wright 1967, 1972) . It was an objective of the current study to contribute to the continuing discussion of whether it is possible to make such determinations. Twelve historic groups were, therefore, included in the present study assess the ancestor - descendant relationships indicated by the discriminant function results.

Results from this analysis were disappointing since no clear association between any of the Late Prehistoric groups and an historic tribe were evident. These results indicate, however, what I have come to believe is the reality of our ability as archaeologists, biological anthropologists, linguists, and ethnologists to make such determinations for most groups. Exceptions do exist, for example Syms (1977) reports consensus regarding the Selkirk - Cree association, and M. Wedel's exemplary work that identifies the Iowa as the historic descendants of the pre- and protohistoric Oneota Orr, or more generally, the western Oneota (M. Wedel 1959, 1979, 1986).

Most studies attempting to illuminate a prehistoric - historic link formulate hypotheses based on a limited amount of information and the belief that historic groups represent stable, isolated cultural and biological units that may be projected into the past. Prehistoric cultures, accordingly, are also perceived as discrete cultural and biological units that act as cohesive entities. As has been demonstrated through more recent

archaeological and ethnohistorical research, this is not a realistic perception of human cultures - either past or present (cf. Headland and Reid 1987). Gibbon (1995:180) summarizes this perspective: "Ethnohistorical studies in anthropology are increasingly challenging the essentialist assumption that early historic labels necessarily identify social groups that can be projected back in time for hundreds of years as bounded social units. In fact, it is now clear that the uniformitarian implications associated with using contemporary ethnic labels in historical and archaeological reconstructions may constrain our understanding of social and cultural change in the past" (Gibbon 1995:180).

Syms (1985) advocates the application of the holistic approach in such undertakings that integrates information derived from linguistic, ethnohistorical, physical anthropological, and archaeological research. He provides numerous examples that highlight "the pitfalls that have been and continue to be stumbling blocks in research efforts due to non-integrated efforts" (Syms 1985:73). Pitfalls that plague the identification of tribal ancestors include simplification of the ethnic diversity that characterizes many areas and the complex interrelationships between these diverse groups, lack of consideration of the biological and cultural consequences of fission and amalgamation of ethnic groups, misuse of linguistic concepts, over-reliance on existing archaeological taxonomies (by biological anthropologists), exclusion (or unavailability of samples from)of some historic groups known to, or hypothesized to have been in an area, and definition of types, components, and complexes based on limited data to name a few. Despite these difficulties, Syms (1985:96) sees "considerable potential for linking various archaeological units to linguistic and ethnic groups at least at a general level.

The Mississippian Oneota materials would appear to be Siouan, as would Great Oasis and Mill Creek. Much of the Woodland material, such as Laurel, Blackduck, Selkirk, appears to be related to Algonquian groups."

My results appear to contradict what Syms (1985) and others see as the most likely descendants of the various groups present in the study region. The Oneota and Initial variant groups do not associate more closely with the Siouan tribes/bands and the Blackduck do not associate very closely to the Algonquian groups. Perhaps these disparities relate to the temporal disconnect between the Late Prehistoric groups included here and the historic samples, most of which are comprised of individuals recovered during the mid- to late 1800s from indigenous cemeteries located within various military forts in North Dakota, South Dakota, Nebraska, and Montana (see Table 3-2). The results may also reflect potential errors in tribal/band identification of the individuals included in the historic samples - a situation complicated, no doubt, by the amalgamation of diverse bands to form new communities/social groups in the wake of devastating epidemics and forced relocation to reservations often geographically distant from the original homelands of these groups. A one-to-one relationship linking prehistory with history in some cases may, therefore, prove to be futile.

I would like to end this discussion with a reminder that the interpretations and conclusions presented here provide a broad overview of population relationships throughout the 10,000 year history of human occupation in Minnesota and surrounding border areas. It is beyond the scope of this dissertation to provide an exhaustive discussion of the implications of the relationships indicated by the results; more thorough

discussion of various aspects of this research will be forthcoming in future research. Nevertheless, I believe that the results of this study provide additional and significant insight into the past and advance our understanding of the complex biological and cultural interactions between the populations that made their homes in the study region.

CHAPTER 6

SUMMARY AND DIRECTIONS FOR FUTURE RESEARCH

This dissertation began with the premise that the most accurate and valid reconstructions of past cultural systems are those that apply a holistic, biocultural approach; this approach is a defining perspective in the discipline of Anthropology. The actual application of this perspective, however, has been lacking in reconstructions of past lifeways in the study region which have to date been based primarily, and solely in many instances, on interpretations of material culture. This one-sided interpretation has resulted in an incomplete understanding of the past in this region.

This dissertation proposed as its primary objective a more holistic comprehension of the complexities of human adaptation and patterns of interaction throughout the 10,000 years of human occupation of Minnesota and contiguous areas in Ontario, Manitoba, North and South Dakota, Nebraska, and Iowa. The foundation of the current study is a biological distance analysis based on a series of measurements taken on crania representing archaeological cultures from the Paleoindian and Archaic traditions through the historic period. The results of the biological distance analysis have been integrated with existing archaeological knowledge to provide a more holistic understanding of patterns of population relationships. More specific objectives included determining patterns of biological interaction through time and between various archaeological "cultures" that inhabited the study region. A second objective related to delineating the

biological/genetic "cohesiveness", or homogeneity, of defined archaeological units (e.g. Blackduck, Mill Creek) from an analysis of the cranial remains from associated (or believed to be) mortuary sites. This objective addressed the theoretical issue of "relating archaeological units to biological populations ..." (Blakeslee 1994:9). This objective is complicated by poorly defined archaeological units (due to lack of information) and the difficulty in accurately assigning mortuary sites and burial episodes to a particular archaeological unit or component. The final, and perhaps most important, objective was an explanatory one: the evaluation of competing hypotheses or models formulated to explain population origins, patterns of cultural and biological interaction among contemporaneous groups, and the transformation or evolution of groups through time and across space within the study region from a bioarchaeological perspective that integrates existing archaeological knowledge with that derived from the analysis of human remains.

The Paleoindian, Archaic and Initial Woodland traditions are characterized, generally, by genetic continuity. The principal components analysis identified an overall similarity in cranial shape that suggests biological affinity between the Browns Valley Paleoindian, the Early Archaic Pelican Rapids individual, and later Archaic and Initial Woodland samples. *In situ* development, as opposed to migration, appears to be the most reasonable explanation for these early cultural transitions in Minnesota. Although the samples are limited in geographic distribution and number of individuals, there is, likewise, little cranial differentiation between the Prairie Archaic and Eastern Archaic tradition samples. This continuity suggests that the increasing regionalization of Archaic communities characteristic of populations to the south of the study region was not

mirrored by biological isolation and heterogeneity. When numerous sample of various world populations are added to the group space, the Minnesota sample clusters together indicating that Browns Valley shares a closer genetic relationships with the later Archaic and Initial Woodland populations than with any of the world populations included in the analysis.

Few definitive conclusions can be presented for the Early to Middle Prehistoric period transition due to limitations of the cranial samples available from the Middle Prehistoric. Displacement of the Paleoindian, as well as the Prairie Archaic sample, from the later Woodland sample, are likely to be the result of the absence of more geographically proximate Middle Woodland Fox Lake and Lake Benton phase cranial samples. Additionally, the results may be cautiously interpreted to indicate some migration into the area by Middle Woodland groups not represented in the sample analyzed here, possibly from Wisconsin or Iowa.

The Late Prehistoric period in the study region was a dynamic period characterized by an increase in population size and the number of groups represented, the existence of broad trade networks, and differing levels of social integration and socio-political complexity. Several important patterns of population relationships were identified. Great Oasis showed genetic discontinuity with the Middle and Late Woodland groups in the study sample and, therefore, is not closely related to them. Consideration of the results of the current analysis and those presented by Key (1995) indicate that Great Oasis is more closely related to the Middle Woodland groups of the Central Plains, including the Valley and Keith phases. Great Oasis also shows similarity in cranial form

to Mill Creek that indicates a close affiliation to this Middle Missouri tradition Initial variant group. Overall, the Initial variant groups are only loosely affiliated; Great Oasis exhibits greater biological affinity to Mill Creek, and Big Stone is more similar to Cambria, as well as to Orr, Silvernale, and Blue Earth. This pattern of relationships likely reflects geographic proximity and location of these phases along, or near to, major transportation corridors (i.e., the Minnesota river). The hypothesized role of the Blue Earth Oneota as middlemen in trade relations between Cahokia and local groups may explain to its intermediate position between the Initial variant-Oneota-Mississippian cluster and the Late Woodland cluster. The Initial variant-Oneota-Mississippian association may also suggest a shared ancestral base that originated outside of the study region, most likely south of the study region.

Discontinuity between the more southern horticultural groups and the more northern Woodland populations is indicative of migration into the region of the Oneota, Middle Missouri, and Mississippian Silvernale groups. The discontinuity is significant given the geographic proximity of the Big Stone, Cambria, and Arvilla groups and provides further evidence that the origins of the Initial variant are not to be found in the local Middle and Late Woodland groups.

The results presented here provide further support for the general belief that the Blackduck phase is comprised of two biologically distinct groups, one situated in the Rainy River region along the present-day Minnesota-Canada border and the other in the Mississippi river Headwaters area in north-central Minnesota. Close affinity of the southern Blackduck group to the Arvilla and Devils Lake - Sourisford groups of the

Northeastern Plains and the discontinuity between these groups (Arvilla and Devils Lake - Sourisford) and the Middle Woodland Central Plains groups (Key 1995) indicate that the place of origin of these Middle and Late Woodland groups is likely to have been in Minnesota; a westward migration of these groups would have occurred later. Definitive proof of a Minnesota homeland for these groups would require Middle Woodland samples from central and northern Minnesota; samples that do not exist.

Significant genetic heterogeneity characterizes the north and south Arvilla, Devils Lake - Sourisford, and northern Blackduck groups. This heterogeneity is not completely unexpected given the lack of unity exhibited by the artifacts recovered from Arvilla and Devils Lake - Sourisford sites and their classification as burial complexes. Despite artifactual evidence of contact between Arvilla, Devils Lake - Sourisford, Blackduck, the Initial variant of the Middle Missouri tradition, and Mississippian groups, genetic affinity is suggested only for the Late Woodland Devils Lake - Sourisford and Arvilla, and Arvilla and Blackduck. Interaction with the Middle Missouri and Mississippian groups is representative of trade networks only with little or no biological interaction.

The close biological affiliation of Arvilla, Devils Lake - Sourisford, and Blackduck, coupled with the genetic heterogeneity of each manifestation, may also be interpreted as evidence for biological interaction between groups practicing a more nomadic hunter-gatherer settlement-subsistence pattern that would facilitate, and depend (to a degree) on, mechanisms of social integration such as marriage exchanges to ensure access to different resource zones and, when needed, allies. The results indicated that significantly different patterns of social integration and network/"alliance" formation

characterized populations in northern and southern regions of the study area. This may be considered further evidence of migration of the southern groups into this region.

No clear descendant tribes/band were identified for any Late Prehistoric group included in this analysis. This may be interpreted as support that those researchers who suggest that we have relied upon a simplistic understanding of the nature of late prehistoric and historic communities relative to socio-political autonomy and patterns of interaction with neighboring groups (Gibbon 1995; Syms 1985). An alternative explanation lies in the composition of the cranial samples analyzed here. It is noted that samples representing all possible historic descendants were not included in this analysis. This is due, for the most part, to the non-existence of these samples and/or inaccessibility of existing historic collections.

As with most research, the results and interpretations presented in this dissertation answer some questions, identify new ones, and necessitate reformulation of existing hypotheses to further clarify our understanding of past cultural systems. With this in mind I offer the following suggestions for future research. First, I believe it would be of great benefit to combine the cranial data set utilized by the current study with those analyzed by Key (1983, 1994),Wyman (personal communication, 1996 and 2000), and Glenn (1974). The combined sample would represent the Southern, Central, and Northern Plains, the northwestern portion of the Eastern Woodlands, and a portion of the Upper Great Lakes. Analysis of this larger and more representative sample would result in a further clarification of the relationships within and between these regions. Additionally, several geographical and temporal gaps exist that, if filled, would

contribute to our understanding of dynamic nature of the populations present during the length of human occupation in this region. Particularly important are the inclusion of crania from western Wisconsin, northwestern Michigan, and northwestern Ontario. Additional samples representing the earliest traditions, including Archaic and Paleoindian, as well as the Initial and Middle Woodland periods, are also necessary.

Several areas relevant to the increasing the quality of and size of the cranial sample should be addressed. First, and most importantly, radiometric dates for all mortuary sites are necessary. This will be an expensive undertaking, but the necessity of doing this cannot be overstated. Radiometric dates are absolutely necessary in order to clarify the taxonomy of burial sites, as well as identify - in conjunction with grave goods and mortuary patterning - the presence of multiple components. Additionally, in order to increase sample sizes and incorporate additional archaeological manifestations (i.e., Sandy Lake), recently available crania should be measured and added to the database. The reliability of a reduced cranial variable set should also be assessed; in the current study, approximately 40 more crania representing most periods could be added to the analysis. Finally, other classes of data, including dental and cranial nonmetric traits, should be analyzed and the biological distance results compared to see if similar patterns of population relationships are indicated. Scherer (1998) conducted a dental nonmetric biodistance study on a sample of Late Prehistoric populations for a portion of the study region represented here and significant congruence between the two studies exist.

In conclusion, I offer this dissertation and the interpretations presented within in the spirit of intellectual inquiry. It is my sincere hope that it will encourage the

reexamination of existing models of interaction and transformation, generate discussion about the patterns of - and evidence for - population relationships, provide insight into the significant contributions biological anthropology can offer to the quest to accurately reconstruct and understand past cultural systems, and stimulate true collaboration between archaeologists and biological anthropologists working in this region.

References Cited

REFERENCES CITED

Alex, R.A.

1981 *The Village Cultures of the Lower James River Valley, South Dakota.* Unpublished Ph.D. dissertation. University of Wisconsin, Madison.

Anderson, D.C.

1969 Mill Creek Culture: A Review. *Plains Anthropologist* 14: 134-143.

1987 Toward a Processual Understanding of the Initial Variant of the Middle Missouri Tradition: The Case of the Mill Creek Culture of Iowa. *American Antiquity* 52(3):522-537.

Anderson, G.C.

1980 Early Dakota Migration and Intertribal War: A Revision. *The Western Historical Quarterly* 11:17-36.

Anderson, W.

1962 *Red River Aspect Skeletal Remains*. Unpublished Master's thesis, Department of Anthropology, University of Minnesota, Minneapolis.

Anderson, D.C., R. Slattery, Jr., and D.M. Wendland

1980 The Cherokee Sewer Site and the Cultures of the Atlantic Climatic Episode. In *The Cherokee Excavations: Holocene Ecology and Human Adaptation in Northwestern Iowa.* Edited by D.C. Anderson and H.A. Semken, Jr., pp. 257-274. Academic Press, New York.

Anfinson, S.F.

1979 Personal communication as reported in Anfinson, 1997a.

1987 *The Prehistory of the Prairie Lakes Region in the Northeastern Plains.* Unpublished Ph.D. dissertation, University of Minnesota, Minneapolis.

1990 Archaeological Regions in Minnesota and the Woodland Period. In *The Woodland Tradition in the Great Lakes: Papers Presented to Elden Johnson,* edited by G.E. Gibbon, pp. 135-166. Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

1995 Personal communication as reported in Anfinson, 1997a.

1997 *Southwestern Minnesota Archaeology: 12,000 Years in the Prairie Lake Region.* Minnesota Prehistoric Archaeology Series, No. 14, Minnesota Historical Society, St. Paul.

1997a *Minnesota Radiocarbon Dates - References.* Unpublished manuscript on file at the State Historic Preservation Office, Minnesota State Historical Society, St. Paul.

Anfinson, S.F., M.G. Michlovic, and J. Stein
1978 *The Lake Bronson Site (21KT1): A Multi-component Prehistoric Site on the Prairie-Woodland Border in Northwestern Minnesota.* Occasional Publications in Minnesota Anthropology No. 3, Minnesota Archaeological Society, Ft. Snelling.

Arthurs, D.W.
1986 *Archaeological Investigations at the Long Sault Site (Manitou Mounds).* Conservation Archaeology Report, Northwestern Region, Report Number 7, Ministry of Citizenship and Culture.

Aufderheide, A.C., E. Johnson, and O. Langsjoen
1994 Health, Demography, and Archaeology of Mille Lacs Native American Mortuary Populations. *Plains Anthropologist* 39-149, Memoir 28.

Baer, M.J. and J.E. Harris
1969 A Commentary on the Growth of the Human Brain and Skull. *American Journal of Physical Anthropology* 30:39-44.

Bailey, F.G.
1969 *Stratagems and Spoils: A Social Anthropology of Politics.* Schocken Books, New York.

Barnes, J.A.
1969 Networks and Political Process. In *Social Networks in Urban Situations: Analysis of Personal Relationships in Central African Towns*, edited by J. Clyde Mitchell, pp. 51-76. Manchester University Press, Manchester, England.

Bass, W.M.
1987 *Human Osteology: A Laboratory and Field Manual of the Human Skeleton.* Special Publications, Missouri Archaeological Society, Columbia, 2nd edition.

Bass, W.M. and T.W. Phenice
1975 Prehistoric Human Skeletal Material from Three Sites in North and South Dakota. In *The Sonota Complex and Associated Sites on the Northern Great Plains*, edited by R.W. Neuman. Nebraska State Historical Society Publications in Anthropology No. 6.

Benchley, E.D., B. Nansel, C.A. Dobbs, S.M.T. Myster, and B.H. O'Connell
1997 *Archeology and Bioarcheology of the Northern Woodlands.* A Volume in the Central and Northern Plains Archeological Overview, Arkansas Archeological Survey, Research Series No. 52.

Bender, B.
1979 Gatherer-Hunter to Farmer: A Social Perspective. *World Archaeology* 10:204-222.

1985 Emergent Tribal Formations in the American Midcontinent. *American Antiquity* 50:52-56.

Benn, D.W.
1983 Diffusion and Acculturation in Woodland Cultures on the Western Prairie Peninsula. In *Prairie Archaeology*, edited by G.E. Gibbon, pp. 75-85. Publications in Anthropology 3. University of Minnesota, Minneapolis.

1989 Hawks, Serpents, and Bird-Men: Emergence of the Oneota Mode of Production. *Plains Anthropologist* 34:233-260.

Benn, D.W., S. Schermer, and J. Sellars
1992 *Excavations of Human Remains from the Sand Run West Site (13LA38) Louisa County, Iowa.* Report prepared for the U.S. Army Corps of Engineers, Rock Island District, Contract No. DAC1025-91-M-0982. Office of the State Archaeologist, Iowa City.

Bennett, J.W.
1952 The Prehistory of the Northern Mississippi Valley. In *Archaeology of the Eastern United States*, edited by J.B. Griffin, pp. 108-123. University of Chicago Press, Chicago.

Bentley, G.R.
1991 A Bioarchaeological Reconstruction of the Social and Kinship Systems at Early Bronze Age Bab edh-Dhra', Jordan. In *Between Bands and States*, edited by S.A. Gregg, pp. 5-34. *Southern Illinois University at Carbondale, Center for Archaeological Investigations, Occasional Paper,* 9.

Binford, L.R.
1967 Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning. *American Antiquity* 32(1):1-12.

Birk, D.A.
1977 The Norway Site: a Multicomponent Woodland Complex in North Central Minnesota. *Minnesota Archaeologist* 36(1):16-45

Bishop, C.A.
1976 The Emergence of the Northern Ojibwa: Social and Economic Consequences. *American Ethnologist* 3:39-54.

1981 Territorial Groups Before 1821: Cree and Ojibwa. In *Subarctic*, Vol. 6, Handbook of North American Indians, edited by J. Helm, pp.158-160. Smithsonian

Institution, Washington, D.C.

Bishop, C.A. and M.E. Smith
1975 Early Historic Populations in Northwestern Ontario: Archaeological and Ethnohistorical Interpretations. *American Antiquity* 40:54-63.

Blakeslee, D.J.
1994 The Archaeological Context of Human Skeletons in the Northern and Central Plains. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence,* edited by D.W. Owsley and R.L. Jantz, pp. 9-32. Smithsonian Institution Press, Washington, D.C.

Blangero, J.
1987 *Population Genetic Approaches to Phenotypic Microevolution in the Jirels of Nepal.* Unpublished Ph.D. dissertation, Case Western Reserve University, Cleveland, Ohio.

Bleed, P.
1969 *The Archaeology of Petaga Point: The Preceramic Component.* Minnesota Historical Society, St. Paul.

Blue, K. B.
1996*a* *Osteological Analysis of Human Remains from the Hogback Site (21HU01).* Unpublished draft manuscript on file at the Hamline University Osteology Laboratory, Department of Anthropology, Hamline University, St. Paul.

1996b *Osteological Analysis of Human Remains from the Voight Site (21WN15).* Unpublished draft manuscript on file at the Hamline University Osteology Laboratory, Department of Anthropology, Hamline University, St. Paul.

1997a *Osteological Report, 21GD4, Bryan Site.* Unpublished draft manuscript on file at the Hamline University Osteology Laboratory, Department of Anthropology, Hamline University, St. Paul.

1997b *Osteological Report, 21PL9, Crookston Mound Site.* Unpublished draft manuscript on file at the Hamline University Osteology Laboratory, Department of Anthropology, Hamline University, St. Paul.

1998 *Osteological Report, 21BS16, Big Stone State Park*, Unpublished draft manuscript on file at the Hamline University Osteology Laboratory, Department of Anthropology, Hamline University, St. Paul.

Borchert, J. R. and N. C. Gustafson
1980 *Atlas of Minnesota Resources and Settlement.* Center for Urban and Regional Affairs, CURA 80-5, Minneapolis.

Boyd, D.C.M.
1988 *A Functional Model for Masticatory-Related Mandibular, Dental, and Craniofacial Microevolutionary Change Derived from a Selected Southeastern Indian Skeletal Temporal Series*. Unpublished Ph.D. dissertation, University of Tennessee, Knoxville.

Bozhardt, R.F., J.L. Theler, and T.F. Kehoe
1986 The Early Woodland State. In *Introduction to Wisconsin Archaeology: Background for Cultural Resource Planning,* edited by W. Green, J.G. Stoltman, and A.B. Kehoe, pp. 243-262. *The Wisconsin Archeologist* 67.

Brace, C.L, M.L. Brace, Y. Dodo, K.D. Hunt, W.R. Leonard, LiY, S. Sangvichien, S.X, and Z.Z.
1990 Micronesians, Asian, Thais and Relations: A Craniofacial and Odontometric Perspective. *Micronesica* (supplement):323-348.

Bray, E. C.
1977 *Billions of Years in Minnesota: The Geological Story of the State.* The Science Museum of Minnesota, St. Paul.

Bray, R.T.
1961 The Flynn Cemetery: An Orr Focus Oneota Burial Site in Allamakee County, Iowa. *Journal of the Iowa Archeological Society* 10:15-25.

Brower, J.V. and D.I. Bushnell
1900 *Memoirs and Explorations in the Basin of the Mississippi: Mille Lacs.* Vol III - Report to the Minnesota Historical Society, St. Paul.

Bryan, K., H. Retzek and F.T. McCann
1938 Discovery of Sauk Valley Man of Minnesota with an Account of the Geology. *Texas Archaeological Society* 10:114-135.

Buchner, A.P.
1979 *The Caribou Lake Project, Including a Summary of the Prehistory of East-Central Manitoba.* Papers in Manitoba Archaeology Final Report No. 8. Department of Tourism and Cultural Affairs, Historic Resources Branch, Winnipeg.

1982 *Material Culture of the Bjorklund Site.* Miscellaneous Paper No. 13. Department of Cultural Affairs and Historical Resources, Historic Resources Branch, Winnipeg.

Buikstra, J.E.
1976 Hopewell in the Lower Illinois Valley: A Regional Study of Human Biological Variability and Prehistoric Mortuary Behavior. *Northwestern University Archeological Program, Scientific Papers* 2.

Buikstra, J.E., S.R. Frankenberg, and L.W. Konigsberg
1990 Skeletal Biological Distance Studies in American Physical Anthropology: Recent Trends. *American Journal of Physical Anthropology* 82:1-7.

Bushnell, D.I.
1927 *Burials of the Algonquian, Siouan and Caddoan Tribes West of the Mississippi.* Bureau of American Ethnology Bulletin 83, Smithsonian Institution, Washington, D.C.

Byrd, J.E. and R.L. Jantz
1994 Osteological Evidence for Distinct Social Groups at the Leavenworth Site. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, edited by D.W. Owsley and R.L. Jantz, pp. 203-208. Smithsonian Institution Press, Washington, D.C.

Caine, C. A. H.
1974 The Archaeology of the Snake River Region in Minnesota. In *Aspects of Upper Great Lakes Anthropology*, edited by E. Johnson, pp. 64-73. Department of Anthropology, University of Minnesota, Minneapolis.

Caldwell, J.R.
1958 *Trend and Tradition in the Prehistory of the Eastern United States.* Scientific Papers X. Illinois State Museum, Springfield.

Caldwell, W.W.
1966 The Middle Missouri Tradition Reappraised. *Plains Anthropologist* 11:152-157.

Caldwell, W.W. and D.R. Henning
1978 North American Plains. In *Chronologies in New World Archaeology*, edited by R.E. Taylor and C.W. Meighan, pp. 113-145. Academic Press, New York.

Capes, K.H.
1963 *The W. B. Nickerson Survey and Excavations, 1912-15, of the Southern Manitoba Mounds Region.* Anthropological Papers of the National Museum of Canada No. 4, Ottawa.

Chafe, W.L
1976 Siouan, Iroquoian, and Caddoan. In *Native Languages of the Americas*, edited by T.A. Sebeok, pp. 527-672. Plenum Press, New York.

Champe, J.L.
1949 A Report for the Laboratory of Anthropology, University of Nebraska, 1940-1947. In *Proceedings of the Fifth Plains Conference for Archeology, Note Book No. 1.* Laboratory of Anthropology, University of Nebraska, Lincoln.

Charles, D.K. and J.E. Buikstra
1983 Archaic Mortuary Sites in the Central Mississippi Drainage: Distribution, Structure, and Behavioral Implications. In *Archaic Hunters and Gatherers in the American Midwest*, edited by J. L. Phillips and J. A. Brown, pp. 117-146. New World Archaeological Record. Academic Press, New York.

Cheverud, J.M.
1988 A Comparison of Genetic and Phenotypic Correlations. *Evolution* 42:958-968.

Cheverud, J.M., J.E. Buikstra, and E. Twitchell
1979 Relationships Between Non-Metric Skeletal Traits and Cranial Size and Shape. *American Journal of Physical Anthropology* 50:191-198.

Clark, P.J.
1956 The heritability of certain anthropometric characters as ascertained from measurements of twins. *American Journal of Human Genetics* 8:49-59.

Clarke, D.L.
1968 *Analytical Archaeology.* Methuen, London.

Cooper, L.R. and E. Johnson
1964 Sandy Lake Ware and Its Distribution. *American Antiquity* 29:474-479.

Corruccini, R.S.
1976 The Interaction Between Nonmetric and Metric Cranial Variation. *American Journal of Physical Anthropology* 44:285-294.

Cross, M. (ed.)
1938 *Father Louis Hennepin's Description of Louisiana: By Canoe to the Upper Mississippi in 1680.* University of Minnesota Press, Minneapolis.

Dawson, K.C.A.
1974 *The McClusky Site.* Mercury Series Paper No. 25, National Museum of Man, Ottawa.

1987 Northwestern Ontario and the Early Contact Period: the Northern Ojibwa from 1615-1715. *Canadian Journal of Archaeology* 11:143-187.

Dice, L. R.
1943 *The Biotic Provinces of North America.* University of Michigan Press, Ann Arbor.

Dickenson, D.W.
1969 *The Vineland Bay Site: An Analysis.* Unpublished Masters Thesis, Department of Anthropology, University of Minnesota, Minneapolis.

Dobbs, C.A.
1982 Oneota Origins and Development: The Radiocarbon Evidence. In *Oneota Studies*, edited by G. Gibbon, pp. 91-106. Publications in Anthropology No. 1, University of Minnesota, Minneapolis.

1984 *Oneota Settlement Patterns in the Blue Earth River Valley, Minnesota.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Minnesota, Minneapolis.

1984a Excavations at the Bryan Site: 1983-1984. *Minnesota Archaeologist* 43:49-58.

1987 *Archaeological Excavations at the Bryan Site (21GD4), Goodhue County, Minnesota: 1983 and 1984.* Reports of Investigations Number 8, The Institute for Minnesota Archaeology, Minneapolis.

1988a *Outline of Historic Contexts for the Prehistoric Period (ca. 12,00 B.P.-A.D. 1700).* Report of Investigations No. 37., Institute for Minnesota Archaeology, Minneapolis.

1988b *Historic Context Outlines: The Contact Period Contexts (ca. 1630 A.D.-1820 (A.D.).* Report of Investigations No. 39, Institute for Minnesota Archaeology, Minneapolis.

1992 *A Pilot Study of High Precision Radiocarbon Dating at the Red Wing Locality.* Reports of Investigations Number 228. Institute for Minnesota Archaeology, Minneapolis.

Dow, M. and J. Cheverud
1985 Comparisons of Distance Matrices in Studies of Population Structure and Genetic Microdifferentiation: Quadratic assignment. *American Journal of Physical Anthropology* 68:367-374.

Droessler, J.
1981 *Craniometry and Biological Distance: Biocultural Continuity and Change at the Late-Woodland Mississippian Interface.* Center for American Archeology, Research Series, Vol. 1.

Emerson, T.E. and R.B. Lewis (eds.)
1991 *Cahokia and the Hinterlands.* University of Illinois Press, Urbana.

Evans, G.E.
1961a *A Reappraisal of the Blackduck Focus or Headwaters Lake Aspect.* Unpublished Master's thesis, Department of Anthropology, University of Minnesota, Minneapolis.

1961b "Ceramic Analysis of the Blackduck Ware and its General Cultural Relationships." Minnesota Academy of Sciences, *Proceedings* 29: 33-54.

Farnsworth, K.B. and T.E. Emerson (editors)
1986 *Early Woodland Archeology.* Kampsville Seminars in Archeology No. 2. Center for American Archeology, Kampsville, Illinois.

Fenneman, N. M.
1938 *Physiography of the Eastern United States.* New York: McGraw-Hill Book Company, Inc.

Fisher, A.K., W.D. Frankforter, J.A. Tiffany, S.J. Schermer, and D.C. Anderson
1985 Turin: A Middle Archaic Burial Site in Western Iowa. *Plains Anthropologist* 30:195-218.

Fisher, A.K.
1983 Human Remains from 13PM23 near Sioux City, Iowa. *Research Papers* 8:275-283. Office of the State Archaeologist, Iowa City.

Fiske, T. and G.W. Hume
1963 The Voight Site. *Minnesota Archeological Newsletter* 5:1-11.

Fitting, J.E.
1970 *The Archaeology of Michigan.* Garden City, NY: Natural History Press.

1978 Regional Cultural Development 300 B.C. to A.D. 1000. In *Northeast*, edited by B.G. Trigger, pp. 44-57. Handbook of North American Indians, vol. 15, W.G. Sturtevant, general editor. Smithsonian Institution, Washington D.C.

Fugle, E.
1962 Mill Creek Culture and Technology. *Journal of the Iowa Archaeological Society* 11:1-126.

Funk, R.E.
1978 Post-Pleistocene Adaptations. In *Handbook of North American Indians,* Vol. 15:*The Northeast.* Smithsonian Institution Press, Washington, D.C.

Gant, R.
1962 The Big Bend Burials, 39BF221. *Over Museum News* 23:3-7.

Gibbon, G.
1972 *The Blue Earth Phase in Minnesota.* Unpublished Manuscript, Department of Anthropology, University of Minnesota, Minneapolis.

1974 A model of Mississippian development and its implications for the Red Wing area. In *Aspects of Great Lakes Anthropology*, edited by E. Johnson. Minnesota Prehistoric Archaeology Series No. 11, Minnesota Historical Society, St. Paul.

1979 The Mississippian occupation of the Red Wing area. *Minnesota Prehistoric Archaeology Series* 13. Minnesota Historical Society, St. Paul.

1982 Oneota Origins Revisited. In *Oneota Studies*, edited by G.E. Gibbon, pp.85-90. Publications in Anthropology No. 1. University of Minnesota, Minneapolis.

1983 The Middle Missouri Tradition in the Minnesota: A Review. *Plains Anthropology* 38-145, Memoir 27.

1986 Does Minnesota Have an Early Woodland? In *Early Woodland Archeology*, edited by Kenneth B. Farnsworth and Thomas E. Emerson, pp. 84-91. Center For American Archeology Press, Kampsville, Illinois.

1989 *Tribalization and Its Causes in Late Woodland Central Minnesota.* Manuscript on file, Wilford Laboratory of Archaeology, University of Minnesota, Minneapolis.

1991 The Mississippian Presence in the Red Wing Area, Minnesota. In *New Perspectives on Cahokia: Views from the Periphery*, edited by J.B. Stoltman, pp. 281-306. Monographs in World Archaeology No. 2. Prehistory Press, Madison, Wisconsin.

1993 The Middle Missouri Tradition in Minnesota: A Review. *Plains Anthropologist* 38:169-187.

1994 Cultures of the Upper Mississippi River Valley and Adjacent Prairies of Iowa and Minnesota. In *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups*, edited by K.H. Schleiser, pp. 128-148. University of Oklahoma Press, Norman.

1995 Oneota at the Periphery: Trade, Political Power, and Ethnicity in Northern Minnesota and on the Northeastern Plains in the Late Prehistoric Period. In *Oneota Archaeology: Past, Present, and Future*, edited by W. Green, pp. 175-199. Report 20, Office of the State Archaeologist, Iowa City, Iowa.

Gibbon, G.E. and C.A.H. Caine

1980 The Middle-Late Woodland transition in eastern Minnesota. *Midcontinental Journal of Archaeology* 5(1):57-72.

Glenn, E.J.

1971 *Physical Affiliations of the Oneota Peoples.* Unpublished Ph.D. dissertation, Department of Anthropology, Indiana University, Bloomington.

1974 *Physical Affiliations of the Oneota Peoples*. Report 7, Office of the State Archaeologist, Iowa City, Iowa.

Goddard, I.
1978 Central Algonquian Languages. In *Handbook of North American Indians*, Vol. 15, *Northeast*, edited by Bruce G. Trigger, pp. 583-587. Smithsonian Institution, Washington, D.C.

Green, W. (editor)
1995 *Oneota Archaeology: Past, Present, and Future.* Report 20, Office of the State Archaeologist, Iowa City, Iowa.

Green, W., J.B. Stoltman, and S.J. Schermer
1986 Introduction to Wisconsin Archaeology: Background for Cultural Resource Planning. *The Wisconsin Archaeologist* 67(3-4).

Greenberg, A.M. and J. Morrison
1982 Group Identities in the Boreal Forest: The Origin of the Northern Ojibwa. *Ethnohistory* 29(2)75-102.

Gregg, M.L.
1994 Archaeological Complexes of the Northeastern Plains and Prairie-Woodland Border. In *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups*, edited by K.H. Schleiser, pp. 71-95. University of Oklahoma Press, Norman.

Griffin, J.
1937 The Archaeological Remains of the Chiwere Sioux. *American Antiquity* 2:180-181.

1946 Culture Change and Continuity in Eastern United States Archaeology. In *Man in Northeastern North America*, edited by F.S. Johnson. Papers of the robert S. Peabody Foundation for Archaeology 3. Phillips Academy, Andover, Massachusetts.

1952 Culture Periods in Eastern United States Archaeology. In *Archaeology of the Eastern United States*, edited by J.B. Griffin. University of Chicago Press, Chicago.

1960 A Hypothesis for the Prehistory of the Winnebago. In *Culture in History: Essays in Honor of Paul Radin*, edited by S. Diamond, pp. 809-868. Columbia University Press, New York.

1964 The Northeast Woods Area. In *Prehistoric Man in the New World*, edited by J.D. Jennings and E. Norbeck, pp. 223-258. University of Chicago Press, Chicago.

Grinnell, G.B.
1972 The Cheyenne Indians: Their History and Ways of Life. Reprint. University of Nebraska Press, Lincoln.

Grobsmith, E.S.
1990 The Plains Culture Area. In *Native North Americans: An Ethnohistoric Approach*, edited by D.L. Boxberger, pp. 167-213. Kendal/Hunt Publishing Company, Dubuque.

Hall, R.L.
1962 *The Archaeology of Carcajou Point: With an Interpretation of the Development of Oneota Culture in Wisconsin*. Two Volumes. University of Wisconsin Press, Madison.

1986 Upper Mississippi and Middle Mississippi Relationships. In *Introduction to Wisconsin Archaeology: Background for Cultural Resource Planning*, edited by W. Green, J.B. Stoltman, and A.B. Kehoe, pp. 365-369. The Wisconsin Archeologist 67(3-4).

Hanihara, T.
1997 Craniofacial Affinities of Mariana Islanders and Circum-Pacific Peoples. *American Journal of Physical Anthropology* 104:411-425.

Hart, I.H.
1956 An Amateur Archaeologist in Northern Minnesota. *Minnesota Archaeologist* 20(2):1-20.

Harvey, A.E.
1979 *Oneota Culture in Northwestern Iowa.* Report 12, Office of the State Archaeologist, Iowa City, Iowa.

Haug, J.K.
1983 *Early Plains Village Sites in Northeastern South Dakota.* Paper presented at the Forty-first Annual Plains Conference , Rapid City, South Dakota.

Hazard, E.B.
1982 *The Mammals of Minnesota*. University of Minnesota Press, Minneapolis.

Headland, T.N. and L.A. Reid
1989 Hunter-Gatherers and Their Neighbors from Prehistory to the Present. *Current Anthropology* 30:43-66.

Heathcote, G.M.
1986 *Exploratory Human Craniometry of Recent Eskaleutian Regional Groups from the Western Arctic and Subarctic of North America: A New Approach to Population*

Historical Reconstruction. BAR International Series 301, London.

Hemphill, B.E.
1998 Biological Affinities and Affinities of Bronze Age Bactrians: III. An Initial Craniometric Assessment. *American Journal of Physical Anthropology* 106:329-348.

1999 Biological Affinities and Adaptations of Bronze age Bactrians: IV. A Craniometric Investigation of Bactrian Origins. *American Journal of Physical Anthropology* 108-173-192.

Henning, D.R.
1967 Mississippian Influences on the Eastern Plains Border: An Evaluation. *Plains Anthropologist* 12:184-193.

1969 Ceramics from the Mill Creek Sites. In Climatic Change and the Mill Creek Culture of Iowa: Part 2, edited by D.R. Henning, pp. 192-280, *Journal of the Iowa Archaeological Society* 16.

1970 Development and Interrelationships of Oneota Culture in the Lower Missouri River Valley. *The Missouri Archaeologist* 32.

1971 Great Oasis Culture Distributions. In *Prehistoric Investigations*, edited by M.B. McKusick, pp. 125-133. Report 3. Office of the State Archaeologist, Iowa City, Iowa.

1971a Origins of Mill Creek. *Journal of the Iowa Archaeological Society* 18: 6-13.

1988 The Ethnohistory of the Dhegihan-Speaking Tribes. *Forty-sixth Annual Plains Conference Program and Abstracts*, p. 43.

1989 *Plains Village Tradition: Eastern Periphery.* Unpublished manuscript on file, Luther College, Decorah, Iowa.

1991 Great Oasis and Emergent Mississippian: The Question of Trade. *Journal of the Iowa Archaeological Society* 38: 1-4.

Henning, D.R. and E.P. Henning
1978 Great Oasis Ceramics. In *Some Studies of Minnesota Prehistoric Ceramics*, pp. 12-26. Occasional Publications in Minnesota Anthropology 2. The Minnesota Archaeological Society, St. Paul.

Hickerson, H.
1962 The Southwestern Chippewa: An Ethnohistorical Study. *American Anthropologist Memoir 92*, 64(3), Part 2, Menasha, Wisconsin.

Hindness, B. and P.Q. Hirst
1975 *Pre-Capitalist Modes of Production.* Routledge and Kegan Paul, London.

Hinshelwood, A.
1984 *The Native Occupation of the Boundary Waters Area to 1775.* Unpublished Master's thesis, Department of Geography, York University, Toronto.

Hlady, W.M.
1952 Manitoba Archaeology. *The Manitoba Arts Review.* 8:24-33.

1964 Indian Migrations in Manitoba and the West. *Historical and Scientific Society of Manitoba.* Series III, No. 17, pp. 24-53, Winnipeg.

1971 An Introduction to the Archaeology of the Woodland Area of Northern Manitoba. *Manitoba Archaeological Newsletter* 8(2-3).

Hlady, W.M. (ed.)
1970 *Ten Thousand Years, Archaeology in Manitoba.* D.W. Friesen and Sons, Altona, Manitoba.

Hodges, D.C.
1994 A Human Mandible from 13WD6, The Correctionville Site, Woodbury County, Iowa. *Research Papers* 19:165-212.

Hoffman, J. J.
1963 Investigations of the Swift Bird House (39DW233) in the Oahe Reservoir, South Dakota. *Plains Anthropologist* 8:249-256.

Hohman-Caine, C. A. and G. E. Goltz
1995 Brainerd Ware and the Early Woodland Dilemma. *The Minnesota Archaeologist* 54:109-129.

Hollow, R.C. and D.R. Parks
1980 Studies in Plains Linguistics: A Review. In *Anthropology of the Great Plains.* edited by W.R. Wood and M. Liberty, pp. 68-97, University of Nebraska Press, Lincoln.

Howard, J. H.
1953 The Southern Cult on the Northern Plains. *American Antiquity* 19:130-138.

1972 Notes on the Ethnogeography of the Yankton Dakota. *Plains Anthropologist* 17:281-307.

Howard, A.M. and D.E. Skinner
1984 Network Building and Political Power in Northwestern Sierra Leone, 1800-65.

Africa 54(2):2-28.

Howells, W. W.
1966 Variability in Family Lines versus Population Variability. *Annals of the New York Academy of Sciences* 134:624-631.

1969 Criteria for Selection of Osteometric Dimensions. *American Journal of Physical Anthropology* 30:451-458.

1973 *Cranial Variation in Man: A Study by Multivariate Analysis of patterns of Differences among Recent Human Populations.* Papers of the Peabody Museum of Archaeology and Ethnology, Volume 67, Harvard University, Cambridge, Massachusetts.

1989 *Skull Shapes and the Map: Craniometric Analyses in the Dispersion of Modern Homo.* Peabody Museum of Archaeology and Ethnology, Volume 79, Havard University, Cambridge, Massachusetts.

Hrdlička, A.
1937 The Minnesota 'Man'. *American Journal of Physical Anthropology* 22(2):175-199.

Hurt, W.
1951 *Report of Investigations of the Swanson Site, 39BR18, Brule County, South Dakota.* Archaeological Studies, Circular 3. South Dakota Archaeological Commission.

1953 *Report of Investigations of the Thomas Riggs Site, 39HU1, Hughes County, South Dakota.* Archaeological Studies, Circular 5. South Dakota Archaeological Commission.

Irish, J.D.
1993 *Biological Affinities of Late Pleistocene Through Modern African Aboriginal Populations: The Dental Evidence.* Unpublished Ph.D. dissertation, Department of Anthropology, Arizona State University, Tempe.

Ishida, H. and Y. Dodo
1997 Cranial Variation in Prehistoric Human Skeletal Remains from the Marianas. *American Journal of Physical Anthropology* 104:399-410.

Ives, J.C.
1962 Mill Creek Pottery. *Journal of the Iowa Archeological Society* 4 (3-4).

Jablow, J.
1951 *The Cheyenne in Plains Indian Trade Relations, 1795-1840.* Monograph 19. J.J. Augustin for the American Ethnological Society, New York.

Jahnke, L.M.
1998 *Impact of Subsistence and Lifestyle Change at the Lindholm Site (21BS3): A Paleopathological Approach.* Unpublished senior honors thesis, Hamline University, St. Paul, Minnesota.

2000 *Paleodietary Reconstruction at the Lindholm (21BS3): Evidence from the Paleopathology and the Phytolith Assemblage.* Paper presented at the Midwest Archaeological / Plains Anthropological Joint Conference, St. Paul, Minnesota.

Jantz, R. L.
1973 Microevolutionary Change in Arika Crania: A Multivariate Analysis. *American Journal of Physical Anthropology* 38:15-26.

1974 The Redbird Focus: Cranial Evidence in Tribal Identification. *Plains Anthropologist* 19:5-13.

1977 Craniometric Relationships of Plains Populations: Historic and Evolutionary Implications. *Plains Anthropologist Memoir* 13: 162-176.

1992 *Analysis of Skeletal Material From Fort Union Trading Post, North Dakota.* Report submitted to Midwest Archaeological Center, Order No. 2 921 L2 0084.

1994 The Social, Historical, and Functional Dimensions of Skeletal Variation. In *Skeletal Biology in the Great Plains: Migrations, Warfare, Health, and Subsistence*, edited by D.W. Owsley and R.L. Jantz, pp. 175-178. Smithsonian Institution Press, Washington, D.C.

1997 Cranial, Postcranial, and Discrete Trait Variation. In *Bioarchaeology of the North Central United States*, edited by D.W. Owsley and J.C. Rose, pp. 240-247. Arkansas Archeological Survey Research Series No. 49, Fayetteville, Arkansas.

Jantz, R.L. and Owsley, D.W.
1994 White Traders in the Upper Missouri: Evidence from the Swan Creek Site. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, edited by D.W. Owsley and R.L. Jantz, pp. 189-201. Smithsonian Institution Press, Washington, D.C.

Jantz, R.L., D.W. Owsley, and P. Willey
1981 Craniometric Variation in the Northern and Central Plains. *Plains Anthropologist* 26:19-30.

Jenks, A.E.
1936 *Pleistocene Man in Minnesota: A Fossil Homo sapiens*. University of Minnesota Press, Minneapolis.

1937 *Minnesota Browns Valley Man and Associated Burial Artifacts*. American Anthropological Association, Memoir 49. Menasha, WI: American Anthropological Organization.

Jenks, A. E. and L. A. Wilford
1938 Sauk Valley Skeleton. *Bulletin of Texas Archaeological and Paleontological Society* 10:136-168.

Jenson, P. and W. Anderson
1960 Rooney Mound Site. *Minnesota Journal of Science* 4:21-28.

Johnson, E.
1961 Cambria Burial Mounds in Big Stone County. *Minnesota Archaeologist* 23(3):53-81.

1962 An "Archaic" Burial Site in Minnesota, Site 21PO3. *Minnesota Archaeologist* 24:92-101.

1964 Twenty New Radiocarbon Dates from Minnesota Archeological Sites. *Minnesota Archaeologist* 26:35-49.

1969 Preliminary Notes on the Prehistoric Use of Wild Rice. *Minnesota Archaeologist* 30(2):31-43.

1971 Excavations at the Gull Lake Dam (21CA27). *Minnesota Archaeologist* 31(2):44-69.

1971 The Northern Margin of the Prairie Peninsula. *Journal of the Iowa Archaeological Society* 18:13-21.

1973 *The Arvilla Complex*. Minnesota Prehistoric Archaeology Series No. 9, Minnesota Historical Society, St. Paul.

1985 The 17th Century Mdewakanton Dakota Subsistence Mode. In *Archaeology, Ecology and Ethnohistory of the Prairie-Forest Border Zone of Minnesota and Manitoba,* edited by J. Spector and E. Johnson, pp. 154-166. J&L Reprint Company, Lincoln, Nebraska.

1986 *Cambria and Cahokia's Northwestern Periphery*. Paper presented at 51st Society for American Archaeology Conference, New Orleans.

1988 *The Prehistoric Peoples of Minnesota*. Minnesota Prehistoric Archaeology Series No. 3, Minnesota Historical Society, St. Paul.

1991 Cambria and Cahokia's Northwestern Periphery. In *New Perspectives on Cahokia: Wiews from the Periphery*, edited by J.B. Stoltman, pp. 307-317. Prehistory Press, Madison, Wisconsin.

Johnston, R. B.
1967 *The Hitchell Site*. Publications in Salvage Archaeology, No. 3. River Basin Surveys, Smithsonian Institution.

Jones, J.K. Jr. and E.C. Birney
1988 *Handbook of Mammals of the North-Central States*. University of Minnesota Press, Minneapolis.

Kaestle, A.
1997 *Molecular Archaeology: An Analysis of Ancient Native American DNA from Western Nevada*. Paper presented at the American Association of Physical Anthropologists Annual Meeting, St. Louis.

Kakaliouras, A.M.
1997 *Documentation of Human Skeletal Remains from the Round Mound Site (21TR01), Traverse County, Minnesota, University of Minnesota Accession Number 111*. Unpublished manuscript on file at the Hamline University Osteology Laboratory, Department of Anthropology, Hamline University, St. Paul.

Keaveny, B., S.M.T. Myster, A. M. Kakaliouras, and B. H. O'Connell
1993 *Intentional Tapping of Human Long Bones from Three Blackduck Sites in Minnesota*. Paper presented at the Midwest Archaeological Conference, Madison, Wisconsin.

Kelly, M. E.
1967 A Burial from Centerville, South Dakota. *Over Museum News* 28:1-20.

Kenyon, W. A.
1970 *Armstrong Mound on the Rainy River*. Canadian Historic Series, Occasional Papers in Archaeology and History, Ottawa Parks Canada.

1986 *Mounds of Sacred Earth: Burial Mounds of Ontario*. Royal Ontario Museum, Archaeology Monograph 9, University of Toronto Press, Toronto.

Key, P .J.
1983 *Craniometric Relationships Among Plains Indians: Culture-Historical and Evolutionary Implications*. Department of Anthropology Report of Investigations Number 34, University of Tennessee, Knoxville.

1994 Relationships of the Woodland Period on the Northern and Central Plains: The Craniometric Evidence. In *Skeletal Biology in the Great Plains: Migrations, Warfare, Health, and Subsistence*, edited by D.W. Owsley and R.L. Jantz, pp. 179-188. Smithsonian Institution Press, Washington, D.C.

Key, P. J. and R. L. Jantz
1990 Statistical Assessment of Population Variability: A Methodological Approach. *American Journal of Physical Anthropology* 82:53-59.

Keyes, C.R..
1927 Prehistoric Man in Iowa. *The Palimpsest* 8(6):185-229.

1934 Antiquities of the Upper Iowa. *The Palimpsest* 15:321-354.

Kimmerle, E.
1997 *Documentation of Human Skeletal Remains from the Morrison Mound Site (21OT02) in Minnesota.* Unpublished Draft Manuscript on file, Hamline University, Osteology Laboratory, St. Paul, Minnesota.

Kinnear, P.R. and C.D. Gray
1995 *SPSS For Windows Made Simple.* Revised Edition. Erlbaum (UK) Taylor and Francis, East Sussex, U.K.

Koezur, P. and J.V. Wright
1976 *The Potato Island Site, District of Kenora, Ontario.* Archaeological Survey of Canada Paper no. 51. National Museum of Man Mercury Series, Ottawa.

Kolar, J.C.
1982 *Hungry Hall and Late Woodland Populations of the Upper Great Lakes.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Toronto.

Konigsberg, L.W.
1987 *Population Genetic Models for Interpreting Prehistoric Intra-Cemetery Biological Variation.* Unpublished Ph.D. dissertation. Northwestern University. Evanston, IL.

1988 Migration models of prehistoric postmarital residence. *American Journal of Physical Anthropology* 77:471-482

1990 Temporal aspects of biological distance: serial correlation and trend in a prehistoric skeletal lineage. *American Journal of Physical Anthropology* 82:45-52.

Konigsberg, L.W. and J.E. Buikstra
1995 Regional approaches to the investigation of past human biocultural structure. In

Regional Approaches to Mortuary Practices, edited by L.A. Beck, pp. 191-220. Plenum Press, New York.

Konigsberg, L.W. and S.D. Ousley
1995 Multivariate quantitative genetics of anthropometric traits from the Boas data. *Human Biology* 67:481-498.

Küchler, A.W.
1964 Manual to Accompany the Map Potential Natural Vegetation on the Conterminous United States. Special Publications American Geographical Society, 36:vi, 1- 40, 116, and map.

Lane, R.A. and A.J. Sublett
1972 Osteology of social organization: residence pattern. *American Antiquity* 36:186-201.

Larsen, C.S.
1997 *Bioarchaeology: Interpreting behavior from the human skeleton*. Cambridge Studies in Biological Anthropology 21, Cambridge University Press.

Lee, R.B
1993 *The Dobe Ju\'hoansi*. Holt, Rinehart and Winston, Inc, New York.

Lehmer, D.J.
1971a *Introduction to Middle Missouri Archaeology*. Anthropology Papers No. 2, National Park Service, Washington D.C.

1971b An Overview of the Middle Missouri Tradition. *Journal of the Iowa Archaeological Society* 18:2-5.

Lenius, B. J. and D. M. Olinyk
1990 The Rainy River Composite: Revisions to Late Woodland Taxonomy. In *The Woodland Tradition in the Western Great Lakes: Papers Presented to Elden Johnson,* edited by G. Gibbon, pp. 45-54. Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

Leverett, F. and F. W. Sardeson
1917 *Surface Formations and Agricultural Conditions of Northeastern Minnesota.* Minnesota Geological Survey, Bulletin No. 13, University of Minnesota, Minneapolis.

Lofstrom, T.
1987 The Rise of Wild Rice Exploitation and its Implications for Population Size and Social Organization in Minnesota Woodland Period Populations. *Minnesota Archaeologist* 46(2):3-6.

Lowie, R.H.
1909 The Assiniboine. *Anthropological Papers of the American Museum of Natural History,* 4:1-270.

Ludwickson, J., D. Blakeslee and J. O'Shea
1981 *Missouri National Recreational River: Native American Cultural Resources.* Interagency Archaeological Services, Denver.

Lugenbeal, E. N.
1976 *The Archaeology of the Smith site: A study of the ceramics and culture history of Minnesota Laurel and Blackduck.* Unpublished Ph.D. dissertation (2 vols), University of Wisconsin, Madison.

1978 The Blackduck Ceramics of the Smith Site (21KC3) and their Implications for the History of Blackduck Ceramics and Culture in Northern Minnesota. *Midcontinental Journal of Archeology* 3:45-68.

Lukacs, J.R. and B.E. Hemphill
1991 The Dental Anthropology of Prehistoric Baluchistan: A Morphometric Approach to the Peopling of South Asia. In *Advances in Dental Anthropology*, edited by M.A. Kelley and C.S. Larsen, pp. 77-119. Wiley-Liss, New York.

Lurie, N.O.
1960 Winnebago Protohistory. In *Culture in History*, edited by S. Diamond, pp. 790-808. Columbia University Press, New York.

MacNeish, R.S.
1954 *The Stott Mound and Village Near Brandon, Manitoba. Annual Report of the National Museum of Canada, 1952-1953.* Bulletin No. 132. National Museum of Canada, Ottawa.

1958 *An Introduction to the Archaeology of Southeast Manitoba.* National Museum of Canada, Bulletin No. *157.*

Manly, B.F.J.
1993 *Multivariate Statistical Methods: A Primer.* 2nd Ed. Chapman and Hall, New York.

Marschner, F.
1974 [1930] *The Original Vegetation of Minnesota: Compiled from U.S. General Land Office Survey Notes.* Map published by the North Central Forest Experiment Station, St. Paul.

Martin, R.
1956-7 *Lehrbuch der Anthropologie.* Revised Third Edition, edited by K. Saller. Gustav Fischer Verlag, Stuttgart, Germany.

Mason, C.L.
1976 Historic Identification and Lake Winnebago Focus Oneota. In *Cultural Change and Continuity: Essays in Honor of James Bennett Griffin*, edited by C.E. Cleland, pp. 335-348. Academic Press, Inc., New York.

Mason, R.J.
1981 *Great Lakes Archaeology.* Academic Press, New York.

Mather, D.
2000 *Archaeological Overview of the Mille Lacs Locality.* Loucks Associates, Inc., Maple Grove. Report prepared for the Minnesota Department of Transportation, St. Paul.

McKay, R.J. and N.A. Campbell
1982 Variable Selection techniques in discriminant analysis. II. Allocation. *British Journal of Mathematical and Statistical Psychology* 35:30-41.

1982 Variable selection techniques in discriminant analysis. I. Description. *British Journal of Mathematical and Statistical Psychology* 35:1-29.

McKern, W. C.
1939 The Midwestern Taxonomic Method as an Aid to Archaeological Culture Study. *American Antiquity* 1:308-310.

1943 Regarding Midwestern Archaeological Taxonomy. *American Anthropologist* 45:315.

1945 *Preliminary Report on the Upper Mississippi Phase in Wisconsin.* Public Museum of the City of Milwaukee Bulletin 16(3).

McKusick, M.B.
1964 *Men of Ancient Iowa.* Iowa State University Press, Ames.

McMillan, A.D.
1995 *Native Peoples and Cultures of Canada: An Anthropological Overview.* Douglas and McIntyre, Toronto.

Meiklejohn, C.
1972 Biological Concommitants of a Model of Band Society. In *International Conference on the Prehistory and Paleoecology of Western North America Arctic and Subarctic,* edited by S. Raymond and P. Schledermann, pp. 133-141.

University of Calgary.

Meyer, R. W.
1993 *History of the Santee Sioux: United States Indian Policy on Trial.* University of Nebraska Press (Revised Ed.), Lincoln.

Meyer, D. and S. Hamilton
1994 Neighbors to the North: Peoples of the Boreal Forest. In *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups*, edited by K.H. Schleiser, pp. 96-127. University of Oklahoma Press, Norman.

Meyer, D. and D. Russell
1987 The Selkirk Composite of Central Canada: A Reconsideration. *Arctic Anthropology* 24:1-31.

Michlovic, M. G.
1979 *The Dead River Site (21OT51).* Minnesota Archaeological Society, St. Paul.

1982 Report on the Red River archaeological survey in Norman County, Minnesota. *Minnesota Archaeologist* 41(2)53-69.

1983 The Red River Valley in the Prehistory of the Northern Plains. *Plains Anthropologist* 28:23-31.

1985 The Problem of Teton Migration. In *Archaeology, Ecology and Ethnohistory of the Prairie-Forest Border Zone of Minnesota and Manitoba,* edited by J. Spector and E. Johnson, pp. 131-145. J&L Reprint Company, Lincoln, Nebraska.

1986 The Archaeology of the Canning Site. *Minnesota Archaeologist* 45(1):3-36.

1987 The Archaeology of the Mooney Site (21NR29). *Minnesota Archaeologist* 46(2):39-66.

1990 Northern Plains-Woodland Interaction in Prehistory. In *The Woodland Tradition in the Western Great Lakes: Papers Presented to Elden Johnson*, edited by G.E. Gibbon, pp. 45-54. Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

1990 Personal communication as reported in Anfinson 1997a.

Michlovic, M., J. Batura, T. Connelloy, and F. Wicek
1977 Is North Arvilla Ancestral Cheyenne? *Minnesota Archaeologist* 36(4):155-160.

Mitchell, J.C.
1969 The Concept and Use of Social Networks. In *Social Networks in Urban*

Situations: Analyses of Personal Relationships in Central African Towns, edited by J.C. Mitchell, pp. 1-50. Manchester University Press, Manchester, England.

Montgomery, H.
1906 Remains of Prehistoric Man in the Dakotas. *American Anthropologist* 8:640-651.

1910 "Calf Mountain" Mound in Manitoba. *American Anthropologist* 12:49-57.

Moore, J.H.
1987 *The Cheyenne Nation: A Social and Demographic History*. University of Nebraska Press, Lincoln.

1996 *The Cheyenne*. Cambridge, MA: Blackwell Publishers, Inc.

Moore-Jansen, P.H. and R.L. Jantz
1986 *A Computerized Skeletal Data Bank for Forensic Anthropology*. Department of Anthropology, University of Tennessee: Knoxville.

Mott, M.
1938 The Relation of Historic Indian Tribes to Archaeological Manifestations in Iowa. *Iowa Journal of History and Politics* 30(3):227-314.

Muller, D.
1995 *A Closer Look at the Human Remains from the Bryan Site (21GD4) Goodhue County, Minnesota*. Unpublished senior honors thesis, Department of Anthropology, University of Minnesota, Minneapolis.

Myster, S.M.T.
2000 *Ten Thousand Years of Population Relationships at the Prairie-Woodland Interface: Cranial Morphology in the Upper Midwest and Contiguous Areas of Manitoba and Ontario*. Paper presented at the Midwest Archaeological / Plains Anthropological Joint Conference, St. Paul, Minnesota.

Myster, S. M. T. and B. H. O'Connell
1997 Bioarcheology of Iowa, Wisconsin, and Minnesota. In *Bioarcheology of the North Central United States*, edited by D.W. Owsley and J.C. Rose, pp. 147-239. Arkansas Archeological Survey, Research Series No. 49.

Nakata, M., P. Yu, B. Davis, and W. E. Nance
1974 Genetic Determinants of Cranio-facial Morphology: a Twin Study. *Annals of Human Genetics, London* 37:431-443.

Nassaney, M.S.
1987 On the Causes and Consequences of Subsistence Intensification in the

Mississippi Alluvial Valley. In *Emergent Horticultural Economies of the Eastern Woodlands*, edited by W.F. Keegan, pp. 129-152. Occasional Paper No. 7. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

Nassaney, M. S. and K.E. Sassaman
1995 *Native American Interactions: Multiscalar Analyses and Interpretations in the Eastern Woodlands.* University of Tennessee Press, Knoxville, Tennessee.

Nelson, A.R.
1998 *A Craniofacial Perspective on North American Indian Population Affinities and Relations.* Unpublished Ph.D. dissertation, University of Michigan, Ann Arbor.

Neuman, R. W.
1963 Field work in Dewey County, South Dakota, Oahe Reservoir area. *Plains Anthropologist* 8:121-122.

1975 *The Sonota Complex and Associated Sites on the Northern Great Plains.* Nebraska State Historical Society Publications in Anthropology, No. 6., Lincoln.

Nicholson, B.A.
1996 Plains Woodland Influx and the Blackduck Exodus in Southwestern Manitoba During the Late Precontact Period. *Manitoba Archaeological Journal* 6:69-86.

Norquist, C. L.
1967a An Historic Indian Burial in Southwestern Renville County (21RN14). *Minnesota Archaeologist* 29(1):18-19.

1967b *Salvage Excavation: Steele Mound Group, Shakopee, Minn.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

Obey, W.A.
1974 The Arvilla People. *Minnesota Archaeologist* 33(3&4):1.

O'Brien, M.J.
1987 Sedentism, Population Growth, and Resource4 Selection in the Woodland Midwest: A Review of Coevolutionary Developments. *Current Anthropology* 28:177-197.

O'Connell, B. H., P. B. Brown and M. H. Regan
1990 *Osteological Analysis of Human Skeletal Material: Science Museum of Minnesota Collections.* A report submitted to the Science Museum of Minnesota.

O'Connell, B. H. and S. T. Myster
1996 *Paleoindian and Early Archaic Human Remains in Minnesota.* Paper presented

at the Plains Anthropological Conference, Iowa City.

Ojakangas, R. W. and C. L. Matsch
1982 *Minnesota's Geology*. University of Minnesota Press, Minneapolis.

Orr, E.
1914 Indian Pottery of the Oneota or Upper Iowa River Valley in Northeastern Iowa. *Iowa Academy of Science Proceedings* 21:231-239.

1963 *Iowa Archaeological Reports, 1934-1939*. Volumes 2, 4, and 8. In Ten Volume Series, edited by M.B. McKusick. Archives of Archaeology 20. Society for American Archaeology. Madison, Wisconsin.

Osborne, R.H. and F.V. DeGeorge
1959 *Genetic Basis of Morphological Variation. An Evaluation and Application of the Twin Study Method*. Harvard University Press, Cambridge.

Ossenberg, N.
1969 *Skeletal Remains from Hungry Hall Mound 2*. Unpublished manuscript on file, Royal Ontario Museum, Toronto.

1974 Origins and Relationships of Woodland Peoples: The Evidence of Cranial Morphology. In *Aspects of Upper Great Lakes Anthropology: Papers in Honor of Lloyd A. Wilford*, edited by E. Johnson, pp.15-39. Minnesota Historical Society Press.

Ousley, S.D. and R.L. Jantz
1996 *FORDISC 2.0: Personal Computer Forensic Discriminant Functions*. University of Tennessee, Knoxville.

Overstreet, D.F.
1995 The Eastern Wisconsin Oneota Regional Continuity. In *Oneota Archaeology: Past, Present, Future,* edited by W. Green, pp. 33-64. Report 20, Office of the State Archaeologist, Iowa City, Iowa.

Owsley, D.W., D.F. Morey and W.B. Turner
1981 Inferring History from Crania: Biological Distance Comparisons of Mill Creek and Early Middle Missouri Tradition Crania with Mandan and Arikara Population Samples. *Plains Anthropologist* 26:301-310.

Peers, L.
1994 *The Ojibwa of Western Canada, 1780 to 1870*. University of Manitoba Press, Winnipeg.

Pentland, D.H.
1978 A Historical Overview of Cree Dialects. In *Papers of the Ninth Algonquian Conference*, edited by William Cowan, pp. 104-126. Carleton University, Ottawa.

Perkl, B.E.
1998 *Cucurbita pepo* from King Coulee, Southeastern Minnesota. *American Antiquity* 63:279-288.

Peterson, L.
1989 Personal communication as reported in Anfinson 1997a.

Peterson, M.Q.
1963 *The Estimation of the Relationship and Biological Distance Between Selected Minnesota Prehistoric Groups*. Unpublished Master's thesis, University of Minnesota, Minneapolis.

1969 Description of the Mill Creek Skeleton from 13PM4. In Climatic Change and the Mill Creek Culture of Iowa: Part 2, edited by D.R. Henning, pp. 281-285. *Journal of the Iowa Archaeological Society* 16.

Pfeiffer, S.
1977 *The Skeletal Biology of Archaic Populations of the Great Lakes Region.* National Museum of Man, Mercury Series No. 64.

1979 Archaic Population Affiliations as Determined by Analysis of Cranial Morphology. *Ontario Archaeology* 32:35-41.

Powell, J.F.
1995 *Dental Variation and Biological Affinity Among Middle Holocene Human Populations in North America.* Unpublished Ph.D. dissertation, Department of Anthropology, Texas A&M University, College Station.

Powell, J. F. and D. G. Steele
1992 A Multivariate Craniometric Analysis of North American Paleoindian Remains. *Current Research in the Pleistocene* 9:59-62.

Price, R. S.
1956 *Early Ceramic Period Sites in Northeastern Nebraska*. Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

Radin, P.
1916 The Winnebago Tribe. Bureau of American Ethnology, 37th Annual Report, Washington, D.C.

Reid, C. S. and G. Rajnovich
1991 Laurel: A Re-evaluation of the Spatial, Social and Temporal Paradigms. *Canadian Journal of Archaeology* 15:193-234.

Rencher, A. C.
1992a Bias in Apparent Classification Rates in Stepwise Discriminant Analysis. *Communications in Statistics: Simulations and Computation* 21(2):373-389.

1992b Interpretation of Canonical Discriminant Functions, Canonical Variates, and Principal Components. *The American Statistician* 46:217-225.

1998 *Multivariate Statistical Inference and Applications.* John Wiley and Sons, Inc., New York.

Reyment, R.A., R.E. Blackith, and N.A. Campbell
1984 *Multivariate Morphometrics*. 2nd ed. Academic Press, New York.

Rhodes, R.A. and E.M. Todd
1981 Subarctic Algonquian Languages. In *Handbook of North American Indians*, Vol. 6, *Subarctic*, edited by J. Helm, pp. 52-66. Smithsonian Institution, Washington, D.C.

Rightmire, G.P.
1970 Bushman, Hottentot and South African Negro Crania Studied by Distance and Discrimination. *American Journal of Physical Anthropology* 33:169-195.

1972 Cranial Measurements and Discrete Traits Compared in Distance Studies of African Negro Skulls. *Human Biology* 44:263-276.

Ritzenthaler, R. E.
1978 Southwestern Chippewa. In *Handbook of North American Indians, Vol. 15, Northeast*, edited by B.G. Trigger, pp. 743-759. Smithsonian Institution, Washington, D.C.

Rogers, E. S.
1978 Southeastern Ojibwa. In *Handbook of North American Indians, Vol. 15, Northeast*, edited by B.G. Trigger, pp. 760-771. Washington, D.C.: Smithsonian Institution.

Rogers, E.S., et al.
1972 A Cree Burial, Moose Factory, Ontario. *Arctic Anthropology* IX:27-34.

Rood, D.S.
1979 Siouan. In *The Languages of Native America: Historical and Comparative Assessment*, edited by L. Campbell and M. Mithun, pp. 236-297. University of

Texas Press, Austin.

Rosing, F.W.
1986 Kith or kin? On the feasibility of kinship reconstruction in skeletons. In *Science in Egyptology*, edited by A.R. David, pp. 223-237. Manchester University Press, Manchester.

Rothhammer, F. and C. Silva
1990 Craniometrical Variation Among South American Prehistoric Populations: Climatic, Altitudinal, Chronological, and Geographic Contributions. *American Journal of Physical Anthropology* 82:9-17.

Saitta, D.J.
1983 On the Evolution of "Tribal" Social Networks. *American Antiquity* 48:820-824.

Sather, N. and R. Dana
1999 Tallgrass Aspen Parkland. *Minnesota Conservation Volunteer*, January - February, pp. 16-27.

Scherer, A.K.
1998 *Late Precontact Dental Morphology and Biological Relationships in the Upper Midwest.* Unpublished senior honors thesis, Hamline University, St. Paul.

Schermer, S.J.
1987 Human Skeletal Remains from 13LO2, the Blood Run National Historic Landmark Site 1984-1986. *Research Papers* 12:61-81.

Schleiser, K.H.
1987 *The Wolves of Heaven; Cheyenne Shamanism, Ceremonies, and Prehistoric Origins.* University of Oklahoma Press, Norman.

1994 Commentary: A History of Ethnic Groups in the Great Plains A.D. 150-1550. In *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups*, edited by K.H. Schlesier, pp. 308-381. University of Oklahoma Press, Norman.

Schwartz, G. M. and G. A. Thiel
1954 *Minnesota's Rocks and Waters: A Geological Story.* The University of Minnesota Press, Minneapolis.

Scott, G.T. and L.L. Loendorf
1976 *Karlstad Ossuary 21MA10.* University of North Dakota, Grand Forks.

Scott, G.R. and C.G. Turner II
1997 *The Anthropology of Modern Human Teeth: Dental Morphology and Its Variation in Recent Human Populations.* Cambridge University Press.

Scullin, M.
n.d. Minnesota's First Farmers? Late Woodland Ceramics and Maize on the Blue Earth River (The Nelson Site: 21BE24). Ms. On file, Department of Anthropology, Mankato State University, Mankato, MN.

Shane, O.
1981 Radiocarbon Chronology for the Late-Prehistoric Period in Southern Minnesota. *American Philosophical Society Yearbook 1980.* Philadelphia.

1991 Final Report to the Minnesota Historical Society: Radiocarbon Assays of Bone from the Browns Valley Skeleton. Science Museum of Minnesota, St. Paul.

Shennan, S. J.
1998 *Archaeological Approaches to Cultural Identity.* New York: Routledge, New York.

Siebert, F.T., Jr.
1967 The Original Home of the Proto-Algonquian People. In *Contributions to Anthropology: Linguistics 1 (Algonquian),* pp. 13-47. Anthropological Series no. 78, National Museum of Canada Bulletin 214.

Sigstad, J.S. and J.K. Sigstad (eds.)
1973 *The Archaeological Field Notes of W.H. Over.* Research Bulletin 1, Office of the State Archaeologist, South Dakota.

Sims, P. K. and G. B. Morey (eds.)
1972 *Geology of Minnesota: a Centennial Volume In Honor of George M. Schwartz.* Minnesota Geological Society, St. Paul.

Sjøvold, T.
1984 A Report on the Heritability of Some Cranial Measurements and Non-metric Traits. In *Multivariate Statistical Methods in Physical Anthropology*, edited by G.N. van Vark and W.W. Howells, pp. 223-246. Dordrecht: D. Reidel Publishing Company.

Smith, B.D. (editor)
1978 *Mississippian Settlement Patterns.* Academic Press, New York.

Smith F. H.
1976 The Skeletal Remains of the Earliest Americans: A Survey. *Tennessee Anthropologist* 1:116-147.

Smith, H. G.
1948 Wilson's Studies of the Hidatsa. *Minnesota Archaeologist* 14(1):33-34.

Snortland, J. S.
1994 Northern Plains Woodland Mortuary Practices. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, edited by D.W. Owsley and R.L. Jantz, pp. 51-70. Smithsonian Institution Press, Washington, D.C.

Snow, D.R.
1976 The Archaeological Implications of the Proto-Algonquian Urheimat. In *Papers of the Seventh Algonquian Conference,* edited by William Cowan, pp. 339-346. Carleton University, Ottawa.

Spence, M.W.
1974 The study of residential practices among prehistoric hunters and gatherers. *World Archaeology* 5: 346-357.

Springer, J.W. and S.R. Witkowski
1982 Siouan Historical Linguistics and Oneota Archaeology. In *Oneota Studies*, edited by G.E. Gibbon, pp. 69-83. University of Minnesota Publications in Anthropology, Number 1, Minneapolis.

SPSS, Inc.
1999 SPSS Base 9.0 Applications Guide, Chicago.

Stafford, T. W., O. C. Shane III and B. H. O'Connell
n.d. Radiocarbon Dating of Minnesota Paleoindians. Unpublished manuscript on file, Department of Anthropology, Hamline University, St. Paul.

Steele, D. G. and J. Powell
1992 Peopling of the Americas: Paleobiological Evidence. *Human Biology* 64:303-336.

Stoltman, J. B.
1973 *The Laurel Culture in Minnesota*. Minnesota Prehistoric Archaeology Series No. 8., Minnesota Historical Society, St. Paul.

1974 Within Laurel Cultural Variability in Northern Minnesota. In *Aspects of Upper Great Lakes Anthropology: Papers in Honor of Lloyd A. Wilford*, edited by E. Johnson, pp. 74-89. Minnesota Historical Society, St. Paul.

1991 Cahokia as Seen from the Peripheries. In *New Perspectives on Cahokia: Views from the Periphery*, edited by J.B. Stoltman, pp. 349-354. Monographs in World Archaeology, No. 2. Prehistory Press, Madison.

Stone, L. M. and D. Chaput
1978 History of the Upper Great Lakes Area. In *Handbook of North American Indians*, Vol. 15, *Northeast*, edited by B.G. Trigger, pp. 602-609. Smithsonian

Institution Press, Washington, D.C.

Strong, W.D.
1940 From History to Prehistory in the Northern Great Plains. *Smithsonian Miscellaneous Collections* 100: 353-394.

Streuver, S.
1964 The Hopewell Interaction Sphere in Riverine-Western Great Lakes Culture History. In *Hopewellian Studies*, edited by J.R. Caldwell and R.L. Hall, pp. 85-106. Scientific Papers 12(3), Illinois State Museum, Springfield.

1965 Middle Woodland Culture History in the Great Lakes Riverine Area. *American Antiquity* 31:211-223.

Susanne, C.
1977 Heritability of Anthropological Characters. *Human Biology* 49(4):573-580.

Swanton, J.R.
1930 Some Neglected Data Bearing on Cheyenne, Chippewa, and Dakota History. *American Anthropologist* 32:156-160.

Syms, E.L.
1977 Cultural Ecology and Ecological Dynamics of the Ceramic Period in Southwestern Manitoba. *Plains Anthropologist Memoir 12.*

1978 *Aboriginal Mounds in Southern Manitoba: An Evaluative Overview.* Contract report submitted to Parks Canada, Western Region, Manitoba.

1979 The Devils Lake-Sourisford Burial Complex on the Northeastern Plains. *Plains Anthropologist* 24:283-308.

1982 The Arvilla Burial Complex: A Reassessment. *Journal of the North Dakota Archaeological Association* 1:135-166.

1985 Fitting People into the Late Prehistory of the Northeastern Plains: A Need to Return to a Holistic Anthropological Approach. In *Archaeology, Ecology and Ethnohistory of the Prairie-Forest Border Zone of Minnesota and Manitoba*, edited by Janet Spector and Elden Johnson, pp. 73-107. J & J Reprint, Lincoln.

Thomas, M.M. and Mather, D. (eds.)
1996 *The McKinstry Site (21KC2): Final Report of Phase III Investigations for MN/DOT S.P. 360-44, Replacement of T.H. 11 Bridge 5178 Over the Little Fork River, Koochiching County, Minnesota.* Loucks and Associates, Inc., Maple Grove. Report prepared for the Minnesota Department of Transportation, St. Paul.

Tiffany, J.A.
1981 Compendium of Radiocarbon Dates from Iowa Archaeological Sites. *Plains Anthropologist* 26:55-73.

1983 An Overview of the Middle Missouri Tradition. In *Prairie Archaeology: Papers in Honor of David A. Baerreis*, edited by G.E. Gibbon, pp. 87-108. Publications in Anthropology Number 3. University of Minnesota, Minneapolis.

1991 Modeling Mill Creek-Mississippian Interaction. In *New Perspectives on Cahokia: Views from the Periphery*, edited by J.B. Stoltman, pp. 319-347. Monographs in World Archaeology no. 2. Prehistory Press, Madison.

Torbenson, M., O. Langsjoen, and A. Aufderheide
1996 Human Remains from McKinstry Mound Two. *Plains Anthropologist* 41(155):71-92.

Tuck, J.A.
1978 Regional Cultural Development, 3000 to 300 B.C. In *Handbook of North American Indians,* Volume 15, *The Northeast,* B.G. Trigger, pp. 28-43. Smithsonian Institution Press, Washington, D.C.

Turner, C.G. II
1985 Dental Search for Native American Origins. In *Out of Asia: Peopling the Americas and the Pacific*, edited by R. Kirk and E. Szathmary, pp. 31-78. Journal of Pacific History, Canberra, Australia.

1987 Late Pleistocene and Holocene Population History of East Asia based on Dental Variation. *American Journal of Physical Anthropology* 73:305-321.

1993 Southwest Indians: Prehistory through Dentition. *National Geographic Research and Exploration* 9:32-53.

Vickers, C.
1947 Burial Traits of the Headwaters Lakes Aspect in Manitoba. *American Antiquity* 13:109-114.

1948 Cultural Affinity in the Minnesota-Manitoba Region. *Minnesota Archaeologist* 14:38-42.

Watrall, C.
1974 Subsistence Pattern Change at the Cambria Site: A Review and Hypothesis. In *Aspects of Upper Great Lakes, Anthropology: Papers in Honor of Lloyd A. Wilford*, edited by E. Johnson. Minnesota Prehistoric Series No. 11, Minnesota Historical Society, St. Paul.

Webb, T. III, E.J. Cushing, and H.E. Wright Jr.
1983 Holocene Changes in the Vegetation of the Midwest. In *Late Quaternary Environments of the United States, Vol 2, The Holocene*, edited by H.E. Wright Jr., pp. 142-165. University of Minnesota Press, Minneapolis.

Wedel, M. M.
1959 Oneota sites on the Upper Iowa River. *The Missouri Archaeologist* 21(2-4).

1961 Indian Villages on the Upper Iowa River. *The Palimpsest* 62:561-592.

1972 Claude-Charles Dutisné: A Review of His 1719 Journeys. *Great Plains Journal* 12:4-25.

1974 Le Sueur and the Dakota Sioux. In *Aspects of Great Lakes Anthropology*, edited by E. Johnson, pp. 157-171. Minnesota Prehistoric Archaeology Series No. 11, Minnesota Historical Society, St. Paul.

1976 Ethnohistory: its payoffs and pitfalls for Iowa archaeologists. *Journal of the Iowa Archaeological Society* 23:1-44.

1978 A Synonymy of Names for the Ioway Indians. *Journal of the Iowa Archeological Society* 25:49-77.

1981 The Ioway, Oto, and Omaha Indians in 1700. *Journal of the Iowa Archaeological Society* 28:1-14.

1986 Peering at the Ioway Indians Through the Mist of Time: 1650-Circa 1700. *Journal of the Iowa Archaeological Society* 33:1-74.

Wedel, W.R.
1961 *Prehistoric Man on the Great Plains.* University of Oklahoma Press, Norman.

Whelan, M.K.
1990 Late Woodland Subsistence System and Settlement Size in the Mille Lacs Area. In *The Woodland Tradition in the Great Lakes: Papers Presented to Elden Johnson*, edited by G.E. Gibbon, pp. 55-75. Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

Wilford, L. A.
1933 *Smith Mound 4.* Unpublished site report on file, Wilford Archaeology Laboratory, Department of Anthropology, University of Minnesota, Minneapolis.

1937a *Minnesota Archaeology with Special Reference to the Mounds Area.* Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University.

1937b *The Schocker Village Site.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1938 *Cambria Village.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1941 A Tentative Classification of the Prehistoric Cultures of Minnesota. *American Antiquity 6:231-249.*

1942a *The Morrison Mounds.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1943a *The Mud Lake Mounds.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1943b *The Osufsen Mounds.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1943c A Tentative Classification of the Prehistoric Cultures of Minnesota. *Minnesota Archaeologist* 9:91-117.

1943d *The Osufsen Mound.* Unpublished manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1945a The Prehistoric Indians of Minnesota: The Headwaters Lakes Aspect. *Minnesota History* 26:312-329.

1945b Three Village Sites of the Mississippi Pattern in Minnesota. *American Antiquity* 11:32-40.

1950a The Prehistoric Indians of Minnesota: Some Mounds of the Rainy River Aspect. *Minnesota History* 31:163-171.

1950b The Prehistoric Indians of Minnesota: The McKinstry Mounds of the Rainy River Aspect. *Minnesota History* 31:231-237.

1952a The McKinstry Mounds of the Rainy River Aspect, *Minnesota Archaeologist* 18:10-14.

1952b *The Wilsey Burial.* Unpublished manuscript, Department of Anthropology, University of Minnesota, Minneapolis.

1955 A Revised Classification of the Prehistoric Cultures of Minnesota. *American Antiquity* 21:130-142.

1956a *The Bryan Site.* Unpublished manuscript, Department of Anthropology, University of Minnesota, Minneapolis.

1956b *Lewis Mounds.* Unpublished manuscript, Department of Anthropology, University of Minnesota, Minneapolis.

1958 *The Hogback Site.* Unpublished Manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1959 *White Oak Point Mounds.* Unpublished Manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1960 The First Minnesotans. In *Minnesota Heritage*, edited by L. M. Brings, pp. 40-79. T.S. Denison, Minneapolis.

1960a *Brostrom Mounds.* Unpublished Manuscript on file, Department of Anthropology, University of Minnesota, Minneapolis.

1970 *Burial Mounds of the Red River Headwaters.* Minnesota Historical Society, St. Paul.

1984 The Ralph Bryan Site, 1951-1952. *Minnesota Archaeologist* 43:21-36.

Wilford, L. A. and J. Brink
1974 The Hogback Site. *Minnesota Archaeologist* 33(1 and 2).

Wilford, L. A., E. Johnson and J. Vicinus
1969 *Burial Mounds of Central Minnesota, Excavation Reports.* Minnesota Prehistoric Archaeology No. 1, Minnesota Historical Society, St. Paul.

Wilkinson, R.G.
1971 Prehistoric Biological Relationships in the Great Lakes Region. *University of Michigan Museum of Anthropology, Anthropological Papers 43.*

Will, G.F. and J.C. Hecker
1944 The Upper Missouri River Valley Aboriginal Culture in North Dakota. *North Dakota Historical Quarterly* 11:1-2.

Willey, G.R. and P. Phillips
1958 *Method and Theory in American Archaeology.* University of Chicago Press, Chicago.

Williams-Blangero, S.
1990 Population Structure of the Jirels: Patterns of Mate Choice. *American Journal of Physical Anthropology* 82:61-71.

Williams-Blangero, S. and J. Blangero
1989 Anthropometric Variation and the Genetic Structure of the Jirels of Nepal. *Human Biology* 61:1-12.

1990 Quantitative Traits and Population Structure: Introduction. *Human Biology* 62:1-4.

Winchell, N.H.
1911 *The Aborigines of Minnesota*. Minnesota Historical Society, St. Paul.

Winnicki, P.
1970 *Analysis of Dentition from the Hungry Hall Site.* Manuscript on file, Department of Anthropology, University of Toronto.

Wissler, C.
1922 *The American Indian: An Introduction to the Anthropology of the New World.* 2nd Ed., Oxford University Press, New York.

Wright, H.E., Jr.
1972 Physiography of Minnesota. In *Geology of Minnesota*, edited by P.K. Sims and G.B. Morey, pp. 561-578. Minnesota Geological Survey, St. Paul.

Wright, J.V.
1963 An Archaeological Survey Along the North Shore of Lake Superior. *Anthropology Papers No. 3*, National Museum of Canada, Ottawa.

1965 A Regional Examination of Ojibwa Culture History. *Anthropologica* 7:198-227.

1967 The Pic River Site: A Stratified Late Woodland Site on the North Shore of Lake Superior. *National Museum of Canada, Bulletin* 296. National Museum of Man, Ottawa, pp. 54-99.

1968a Prehistory of Hudson Bay – the Boreal Forest. In *Science, History and Hudson Bay*, Vol. 1, ed. C.S. Beals and D.A. Shenstone. Ottawa.

1968b The Michipicoten Site, Ontario. *National Museum of Canada Bulletin* 224, Paper No. 1. National Museum of Canada, Ottawa, pp. 1-85.

1971 Cree Culture History in the Southern Indian Lake Region. *National Museum of Canada Bulletin* 232. National Museum of Man, Ottawa.

1972 *Ontario Prehistory: An Eleven-Thousand Year Archaeological Outline.* National Museum of Man, Ottawa.

Appendices

Appendix Table 1-1. Primary Site References and Collection Status.

Site Number	Site Name	Collection Status	Primary References
IOWA			
13AM43	Flynn	Repatriated	Bray 1961
13LO02	Blood Run	Repatriated	Glenn 1974; Harvey 1979; Schermer 1987
13PM01	Broken Kettle	Repatriated	Key 1983; Orr 1963; Owsley et al. 1981; Tiffany 1981
13PM04	Kimball	Repatriated	Fisher 1983; Fugle 1962; Peterson 1969; Tiffany 1981
13WD06	Correctionville	Repatriated	Hodges 1994; Lillie 1990
MINNESOTA			
21BE06	Lewis Mound	Reburied	Johnson 1961; Wilford 1956b
21BL01	Schocker	Reburied	Evans 1961a; Johnson 1964; Wilford 1937a, 1937b
21BS03	Lindholm Mounds	Reburied	Jahnke 1998; Peterson 1963; Wilford 1970
21BS16	Big Stone State Park	Reburied	Blue 1998
21BW82	Helget	Repatriated	Unpublished notes on file, Hamline University Osteology Laboratory, St. Paul
21CA02	Mud Lake Mounds	Reburied	Evans 1961a; Wilford 1937a, 1943a
21FA02	Vosburg	Repatriated	Gibbon 1972
21FL09	Rushford Mound	Repatriated	Wilford 1937a
21GD04	Bryan	Repatriated	Blue 1997a; Dobbs 1984, 1987a; Johnson 1964; Muller 1995; Wilford 1956a
21HU01	Hogback	Repatriated	Blue 1996a; Peterson 1963; Wilford 1958; Wilford and Brink 1974
21HU04	Wilsey	Repatriated	Wilford 1952b
21IC01	White Oak Point Mds.	Reburied	Wilford 1959
21IC02	Osufsen Mound	Reburied	Evans 1961a; Wilford 1937a, 1943b
21KC02	McKinstry Mounds	Reburied	Stoltman 1973; Peterson 1963; Thomas and Mather 1996;Wilford 1950a, 1950b
21KT01	Lake Bronson	Reburied	Anderson 1962; Johnson 1973
21MA01	Snake River Mounds	Reburied	Anderson 1962; Johnson 1973
21MA06	Harstaad Mound	Reburied	Johnson 1973

Appendix Table 1-1 (continued).

Site Number	Site Name	Collection Status	Primary References
21MA10	Karlstad Ossuary	Reburied	Scott and Loendorf 1976
21ML07	Vineland Bay	Repatriated	Aufderheide et al. 1994 Dickinson 1969
21ML11	Petaga Point	Repatriated	Aufderheide et al. 1994; Bleed 1969
21ML16	Cooper Mounds	Reburied	Aufderheide et al. 1994;
21NR01	Slininger Mound	Reburied	Anderson 1962; Johnson 1973
21OT02	Morrison Mounds	Reburied	Kimmerle 1997; Wilford et al. 1969
21OT03	Pelican Rapids	Reburied	Hrdlička 1937; Jenks 1936; O'Connell and Myster 1996; F. Smith 1976; Wilford 1937a
210T04	Jacobs Farm	Repatriated	Unpublished notes on file, Hamline University Osteology Laboratory, St. Paul
21OT78	Clitherall	Reburied	Unpublished notes on file, Hamline University Osteology Laboratory, St. Paul
21PL03	Warner & Lee Mounds	Reburied	Anderson 1962; Johnson 1973
21PL09	Crookston Mounds	Reburied	Anderson 1962; Blue 1997b; Peterson 1963
21PO03	Pelican Lake Gravel Pit	Reburied	Johnson 1962
21PO13	Rooney Mound	Reburied	O'Connell, Brown and Regan 1990; Jenson and Anderson 1960
21PO14	Noyes	Reburied	Anfinson 1978
21RL01	Red Lake River Mounds	Reburied	Anderson 1962; Johnson 1973
21RN14	Kemnitz	Reburied	Norquist 1967a
21SC24	Steele Mound Group	Reburied	Norquist 1967b
21TO01	Sauk Valley	Reburied	Jenks and Wilford 1938; O'Connell and Myster 1996; F. Smith 1976; Wilford 1937a
21TR01	Round Mound	Reburied	Anderson 1962; Kakaliouras 1997; Wilford 1937a, 1970
21TR05	Browns Valley	Reburied	Jenks 1936, 1937; O'Connell and Myster 1996; F. Smith 1976; Wilford 1937a
21WB01	Brostrom Mounds	Reburied	Wilford 1960a
21WL01	Femco Mound	Reburied	Anderson 1962; Wilford 1970
21WN15	Voight	Reburied	Fiske and Hume 1963; Blue 1996b

Appendix Table 1-1 (continued).

Site Number	Site Name	Collection Status	Primary References
NEBRASKA			
25CRS		Unknown	
25DK02W	Ryan	Unknown	Champe 1949; Price 1956
25NH04	Whitten	Unknown	Nebraska State Historical Society site files
NORTH DAKOTA			
32	Kettle	Unknown	
32RM19		Unknown	North Dakota Office of the State Archaeologist
32SI01	Boundary Mounds	Unknown	North Dakota Office of the State Archaeologist
32WA–	Forest River Mounds	Repatriated	Montgomery 1906; Syms 1979
32WE401	Heimdal Mound	Repatriated	Howard 1953; Syms 1979
32WI17	Fort Union Icehouse	Unknown	Jantz 1992
SOUTH DAKOTA			
39BF221	Big Bend Burials	Unknown	Gant 1962
39BF225	Sitting Crow	Repatriation in Process	Neuman 1963
39CH54/55	Snake River Burials	Unknown	South Dakota Office of the State Archaeologist
39CH07	Oldham	Unknown	Johnston 1967
39CL06	Charley Minnetonka	Reburied	Kelly 1967
39CL01C	Vermillion Bluff Village	Reburied	
39CL01A	Vermillion Bluff Village	Reburied	Sigstad and Sigstad 1973:29
39CL01B	Vermillion Bluff Village	Reburied	Sigstad and Sigstad 1973:30
39DW233	Swift Bird	Unknown	Hoffman 1963; Neuman 1963, 1975
39DW240	Grover Hand	Unknown	Neuman 1975
39DW252	Arpan	Unknown	Bass and Phenice 1975; Neuman 1975

Appendix Table 1-1 (continued).

Site Number	Site Name	Collection Status	Primary References
39RO10	Daugherty Mnd	Reburied	Sigstad and Sigstad 1973
39RO02	Madsen's Mounds	Reburied	Sigstad and Sigstad 1973
39RO23	De Spiegler	Reburied	Anderson 1963; Johnson 1973
39RO03	Buchannon Mnd	Reburied	Sigstad and Sigstad 1973
39RO04	Hartford Bch Md	Reburied	Sigstad and Sigstad 1973
39ST–		Unkown	
39UN01	Arbor Hill	Unknown	Ludwickson et al. 1981:203
MANITOBA			
	Arden Mound	Maintained	Capes 1963; Syms 1978
	Darlingfor Mound	Maintained	Montgomery 1910; Syms 1978
	Pilot Mound	Maintained	Capes 1963; Syms 1978
ONTARIO			
	Hungry Hall Mound A	Maintained	Kenyon 1986; Kolar 1982; Winnicki 1970
	Hungry Hall Mound B	Maintained	Kenyon 1986; Kolar 1982
	Moose Factory Island	Maintained	Rogers et al. 1972
	Mound Point Mound	Maintained	Kenyon 1986
	Oak Point Island	Maintained	Kenyon 1986

Note: Osteological data, notes, and other references for all Minnesota sites are on file at the Hamline University Osteology Laboratory, St. Paul.

Appendix 2-1. Means and Standard Deviations by Phase and Sex.

Phase	Sex	N	Statistic	GOL	XCB	BNL	BBH	WFB	NAH	ZYB	ASB	BPL	NHH	NLB
Paleoindian	Male	1	Mean	193.00	136.50	105.21	133.69	92.10	65.0	141.84	111.00	99.80	48.00	24.20
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Early Archaic	Female	1	Mean	179.30	138.60	99.93	127.08	93.90	65.20	126.00	114.5	96.62	48.80	21.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Prairie Archaic	Male	3	Mean	188.03	142.5	106.7	140.33	90.27	71.06	143.95	114.80	102.70	54.41	26.05
			(SD)	(1.70)	(3.12)	(5.57)	(6.81)	(6.27)	(2.70)	(2.08)	(2.62)	(5.64)	(1.23)	(1.92)
Eastern Archaic	Male	2	Mean	192.20	140.75	105.70	130.35	93.40	70.50	141.42	110.60	106.75	51.00	23.30
			(SD)	(1.70)	(2.48)	(2.12)	(4.73)	(3.11)	(3.54)	(0.59)	(1.98)	(6.01)	(0.00)	(0.99)
Eastern Archaic	Female	2	Mean	181.60	138.05	99.97	128.64	91.05	63.10	133.39	109.10	96.62	48.25	24.85
			(SD)	(6.93)	(4.17)	(0.05)	(2.21)	(6.86)	(1.27)	(2.71)	(4.38)	(0.00)	(0.35)	(1.77)
Woodland	Male	4	Mean	184.78	141.80	104.93	131.07	95.88	69.00	144.67	113.35	95.10	53.55	26.90
			(SD)	(4.99)	(3.71)	(2.96)	(6.79)	(6.79)	(3.16)	(3.29)	(3.21)	(5.42)	(3.94)	(2.90)
Woodland	Female	2	Mean	177.10	135.35	100.80	125.25	89.75	67.75	134.10	110.50	99.10	52.25	23.90
			(SD)	(1.56)	(4.03)	(8.91)	(10.3)	(2.48)	(1.77)	(8.34)	(6.36)	(2.97)	(1.77)	(0.85)
Late Woodland	Male	11	Mean	185.67	141.36	106.10	133.77	96.08	71.14	143.05	113.44	100.50	55.36	26.04
			(SD)	(3.65)	(3.46)	(2.82)	(2.98)	(2.26)	(5.70)	(2.32)	(3.15)	(2.94)	(2.96)	(1.51)
Late Woodland	Female	4	Mean	178.88	139.00	100.53	129.77	92.90	73.40	132.32	108.48	94.13	54.20	26.36
			(SD)	(5.69)	(4.97)	(3.08)	(4.28)	(1.19)	(4.65)	(4.62)	(4.20)	(4.17)	(3.40)	(2.11)
Sonota	Male	6	Mean	183.17	139.83	103.87	128.45	92.67	71.83	143.50	110.33	102.13	55.17	27.00
			(SD)	(5.49)	(4.40)	(2.66)	(2.76)	(3.88)	(2.14)	(6.69)	(3.98)	(2.52)	(2.79)	(1.27)
Sonota	Female	4	Mean	180.5	141.75	98.00	129.50	89.75	68.00	136.50	110.25	98.25	52.75	26.00
			(SD)	(0.58)	(4.72)	(4.90)	(3.42)	(5.91)	(4.08)	(9.54)	(5.85)	(5.25)	(3.86)	(2.16)
Arvilla, North	Male	8	Mean	183.84	140.20	104.78	132.01	92.23	71.68	141.04	111.79	99.76	56.64	25.00
			(SD)	(6.30)	(2.88)	(4.89)	(5.65)	(2.92)	(4.47)	(3.99)	(3.76)	(3.91)	(5.39)	(2.01)
Arvilla, North	Female	11	Mean	178.21	138.04	99.86	125.78	91.61	66.15	132.60	110.27	94.92	51.05	24.73
			(SD)	(5.80)	(2.83)	(4.48)	(4.59)	(4.21)	(4.37)	(4.33)	(3.34)	(2.99)	(3.32)	(2.01)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	GOL	XCB	BNL	BBH	WFB	NAH	ZYB	ASB	BPL	NHH	NLB
Arvilla, South	Male	12	Mean	186.67	142.67	103.68	130.81	91.67	71.58	141.33	111.00	98.65	55.33	25.92
			(SD)	(4.67)	(6.02)	(4.47)	(5.24)	(4.80)	(3.80)	(4.94)	(6.45)	(4.11)	(3.23)	(1.98)
Arvilla, South	Female	13	Mean	178.98	137.00	100.53	128.93	89.31	68.06	129.39	107.00	97.33	51.80	25.27
			(SD)	(3.64)	(5.57)	(3.21)	(4.92)	(4.72)	(3.07)	(5.14)	(4.08)	(3.37)	(2.91)	(1.59)
Devils Lake-Souris.	Male	10	Mean	186.45	140.75	105.60	132.35	92.50	71.52	141.65	111.17	99.46	54.76	26.05
			(SD)	(6.47)	(4.51)	(4.12)	(3.82)	(5.49)	(2.80)	(5.89)	(6.97)	(3.77)	(2.78)	(1.72)
Devils Lake-Souris.	Female	9	Mean	180.34	140.61	101.49	130.01	93.22	68.43	133.17	109.52	97.19	52.74	24.69
			(SD)	(4.70)	(4.74)	(2.16)	(3.63)	(4.01)	(3.25)	(3.84)	(4.75)	(3.76)	(2.50)	(1.98)
Blackduck, North	Male	19	Mean	185.76	145.03	105.79	136.64	97.58	71.15	142.43	115.29	102.12	54.28	26.32
			(SD)	(3.63)	(3.81)	(4.49)	(4.66)	(3.53)	(3.69)	(3.27)	(5.05)	(2.59)	(2.59)	(1.92)
Blackduck, North	Female	8	Mean	179.6	143.31	102.01	129.84	93.24	67.72	134.11	115.30	98.55	52.41	25.81
			(SD)	(3.16)	(2.05)	(4.06)	(5.43)	(2.84)	(0.99)	(4.70)	(4.99)	(3.98)	(1.48)	(1.15)
Blackduck, South	Male	14	Mean	183.75	138.85	103.42	133.74	93.66	72.46	141.28	112.29	97.71	55.16	26.18
			(SD)	(6.26)	(4.60)	(2.77)	(4.60)	(3.66)	(2.33)	(6.01)	(4.28)	(3.19)	(2.51)	(1.24)
Blackduck South	Female	5	Mean	176.26	141.04	97.10	125.32	93.30	68.60	130.28	111.98	95.26	54.31	30.54
			(SD)	(9.69)	(6.26)	(4.55)	(5.48)	(3.97)	(3.21)	(1.67)	(3.25)	(6.04)	(7.00)	(12.8)
Great Oasis	Male	2	Mean	186.50	140.00	112.00	146.50	93.50	75.00	141.00	112.50	103.00	57.00	25.50
			(SD)	(13.44)	(8.49)	(0.00)	(3.54)	(2.12)	(0.00)	(2.83)	(0.71)	(5.66)	(0.00)	(0.71)
Great Oasis	Female	5	Mean	174.40	135.00	99.99	130.60	88.20	70.80	134.20	106.20	95.80	52.00	25.40
			(SD)	(9.34)	(6.67)	(3.94)	(3.85)	(3.27)	(3.90)	(6.83)	(5.22)	(3.90)	(3.39)	(0.89)
Cambria	Male	1	Mean	184.50	132.5	105.50	139.0	95.0	71.00	142.50	116.50	99.00	54.00	29.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Big Stone	Male	5	Mean	181.90	138.26	105.90	133.78	93.16	68.90	143.37	113.83	100.40	53.58	26.51
			(SD)	(7.09)	(3.76)	(1.52)	(2.54)	(2.55)	(5.61)	(4.04)	(2.44)	(2.63)	(2.80)	(5.00)
Big Stone	Female	4	Mean	183.80	136.75	103.51	131.85	92.18	68.78	138.40	110.49	101.46	52.65	24.10
			(SD)	(5.38)	(3.71)	(3.57)	(3.58)	(8.22)	(4.02)	(4.32)	(2.65)	(4.05)	(1.12)	(2.53)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	GOL	XCB	BNL	BBH	WFB	NAH	ZYB	ASB	BPL	NHH	NLB
Mill Creek	Male	3	Mean	180.67	142.67	105.67	144.33	90.33	71.67	136.00	115.00	98.67	54.33	28.00
			(SD)	(5.69)	(4.51)	(2.89)	(1.16)	(3.79)	(3.51)	(5.00)	(2.65)	(2.52)	(0.58)	(3.61)
Mill Creek	Female	1	Mean	158.00	132.0	98.00	125.00	87.00	69.00	125.0	101.00	97.00	51.00	23.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Vermillion Bluff	Male	1	Mean	178.00	140.00	109.00	140.00	90.00	68.00	142.00	108.00	98.00	52.00	27.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Blue Earth	Male	6	Mean	180.73	137.05	106.53	136.85	92.33	69.72	137.17	108.08	98.52	53.75	26.20
			(SD)	(5.36)	(5.65)	(8.36)	(6.10)	(3.55)	(2.95)	(3.36)	(4.88)	(7.11)	(2.47)	(0.98)
Blue Earth	Female	2	Mean	177.00	132.50	95.05	125.35	89.00	64.50	129.74	111.10	94.06	48.50	24.50
			(SD)	(0.00)	(2.12)	(2.90)	(3.04)	(7.07)	(6.36)	(2.45)	(2.69)	(3.62)	(2.12)	(0.71)
Orr	Male	6	Mean	184.92	141.08	105.04	136.42	94.12	70.94	141.18	113.30	98.43	54.00	26.29
			(SD)	(6.00)	(6.20)	(5.40)	(6.14)	(3.63)	(1.79)	(6.19)	(4.55)	(3.03)	(2.54)	(2.77)
Orr	Female	7	Mean	169.51	138.87	98.50	130.59	91.07	64.92	129.42	108.47	93.75	48.27	24.80
			(SD)	(8.97)	(6.44)	(5.28)	(7.08)	(1.91)	(5.88)	(3.47)	(4.21)	(5.01)	(3.10)	(1.02)
Silvernale	Female	2	Mean	188.75	142.00	107.00	139.50	97.50	74.50	151.00	115.00	102.95	55.05	26.50
			(SD)	(5.30)	(1.41)	(8.49)	(2.12)	(2.83)	(2.12)	(1.41)	(2.12)	(5.59)	(1.34)	(3.54)
Assiniboine	Male	4	Mean	185.00	137.63	104.88	130.15	92.98	69.90	136.46	112.90	98.08	53.53	26.22
			(SD)	(3.37)	(2.06)	(2.25)	(4.77)	(2.83)	(3.30)	(4.59)	(3.82)	(1.22)	(1.89)	(0.84)
Assiniboine	Female	4	Mean	183.25	143.75	101.00	125.75	93.38	69.03	134.00	111.50	97.53	51.98	26.03
			(SD)	(6.40)	(6.70)	(4.24)	(3.86)	(2.14)	(6.26)	(1.63)	(5.45)	(5.23)	(3.47)	(2.19)
Cheyenne	Male	16	Mean	180.94	141.44	103.25	133.13	96.94	69.69	142.75	110.38	99.31	55.44	26.44
			(SD)	(5.62)	(4.76)	(3.87)	(5.68)	(4.37)	(4.30)	(5.77)	(2.68)	(5.10)	(5.11)	(1.59)
Cheyenne	Female	6	Mean	168.50	137.00	95.83	125.17	90.17	66.33	129.33	104.83	92.50	51.00	24.00
			(SD)	(3.08)	(3.58)	(4.07)	(2.56)	(2.56)	(3.83)	(6.92)	(4.54)	(7.50)	(4.24)	(2.45)
Cree	Male	1	Mean	177.00	144.00	104.00	124.00	91.65	68.00	139.00	110.00	97.90	53.10	24.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	GOL	XCB	BNL	BBH	WFB	NAH	ZYB	ASB	BPL	NHH	NLB
Ojibwa	Male	11	Mean	183.61	145.57	104.35	134.36	97.06	67.91	143.67	113.98	99.04	53.54	26.44
			(SD)	(4.09)	(4.23)	(3.25)	(5.87)	(3.71)	(5.04)	(3.34)	(3.79)	(2.08)	(2.54)	(1.49)
Ojibwa	Female	5	Mean	168.90	135.34	98.69	125.44	90.46	65.76	132.63	108.18	97.85	50.57	25.43
			(SD)	(3.83)	(3.74)	(3.11)	(1.16)	(2.10)	(3.49)	(2.23)	(3.94)	(2.90)	(2.76)	(0.86)
Mdewakanton	Male	1	Mean	174.00	141.00	100.00	137.00	91.00	68.00	141.84	111.75	91.50	55.00	28.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Oglala	Male	5	Mean	182.54	143.80	103.72	129.50	95.94	70.98	143.99	112.68	99.18	56.88	27.76
			(SD)	(5.10)	(5.02)	(3.01)	(4.17)	(3.06)	(4.18)	(3.21)	(2.19)	(5.58)	(5.49)	(2.05)
Oglala	Female	6	Mean	179.00	136.92	101.42	127.67	92.67	69.09	135.33	108.45	98.47	52.21	27.48
			(SD)	(4.20)	(3.26)	(2.71)	(1.40)	(3.16)	(4.99)	(3.12)	(2.03)	(5.10)	(2.34)	(5.78)
Santee	Male	4	Mean	181.75	138.00	103.50	132.25	93.75	74.25	140.25	112.25	98.00	56.25	25.75
			(SD)	(4.03)	(2.83)	(3.87)	(4.27)	(4.65)	(3.59)	(3.40)	(4.92)	(2.83)	(2.06)	(1.89)
Santee	Female	6	Mean	176.17	135.83	99.50	126.50	91.50	69.12	130.83	106.83	96.77	51.33	24.35
			(SD)	(6.27)	(3.76)	(3.62)	(4.04)	(3.27)	(2.51)	(3.87)	(2.93)	(5.71)	(3.20)	(2.17)
Sisseton-Wahpeton	Female	3	Mean	181.83	131.83	102.00	130.90	92.07	72.00	128.70	104.33	97.93	52.70	25.20
			(SD)	(3.88)	(2.26)	(3.00)	(4.72)	(2.00)	(3.61)	(3.25)	(3.22)	(4.30)	(0.52)	(2.03)
Teton	Male	6	Mean	185.17	144.83	106.87	131.28	99.64	74.33	147.00	113.17	102.13	56.33	26.50
			(SD)	(7.57)	(4.92)	(3.29)	(4.85)	(7.19)	(6.86)	(4.24)	(3.97)	(5.05)	(2.42)	(1.52)
Teton	Female	4	Mean	176.75	140.30	100.00	127.25	97.00	69.75	134.87	112.25	98.25	53.00	27.00
			(SD)	(0.96)	(5.16)	(2.94)	(3.78)	(7.48)	(2.22)	(5.81)	(2.06)	(6.02)	(1.15)	(1.41)
Yankton	Male	4	Mean	177.25	142.25	102.50	133.50	96.25	73.75	140.25	110.00	99.25	54.25	24.00
			(SD)	(2.06)	(5.68)	(5.07)	(5.00)	(4.11)	(3.50)	(4.92)	(5.23)	(3.40)	(2.50)	(1.83)
Siouan	Male	15	Mean	184.00	143.20	104.93	131.93	96.73	74.08	142.80	111.74	101.56	56.37	26.13
			(SD)	(8.44)	(3.32)	(4.45)	(7.93)	(6.35)	(5.44)	(5.96)	(4.80)	(4.97)	(3.03)	(1.77)
Siouan	Female	8	Mean	173.75	139.63	96.75	125.13	90.13	67.50	131.13	106.38	94.25	50.00	24.75
			(SD)	(8.43)	(3.29)	(3.33)	(4.26)	(4.36)	(2.56)	(6.81)	(6.02)	(4.03)	(3.86)	(2.05)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	GOL	XCB	BNL	BBH	WFB	NAH	ZYB	ASB	BPL	NHH	NLB
Winnebago	Male	2	Mean (SD)	174.80 (1.84)	147.25 (8.84)	101.05 (0.07)	126.25 (3.18)	95.05 (2.90)	73.75 (5.30)	145.85 (0.92)	113.05 (2.90)	99.00 (4.24)	55.00 (1.41)	25.75 (1.06)
Winnebago	Female	1	Mean (SD)	171.5 .	136.5 .	100.50 .	130.00 .	88.10 .	64.00 .	131.0 .	101.00 .	92.00 .	37.90 .	24.10 .

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	MAB	MAL	MBD	OBH	OBB	DKB	WNB	ZMB	SSS	FMB	NAS
PaleoIndian	Male	1	Mean	62.20	54.57	14.00	34.00	38.81	21.95	8.53	102.5	25.07	95.50	15.10
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Early Archaic	Female	1	Mean	65.10	52.98	8.10	34.99	40.10	17.70	8.45	90.00	18.00	92.10	19.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Prairie Archaic	Male	3	Mean	63.34	57.12	15.53	33.74	42.90	18.85	7.73	104.6	26.72	97.73	17.97
			(SD)	(2.42)	(3.12)	(1.23)	(1.40)	(1.54)	(2.10)	(0.55)	(3.84)	(1.53)	(0.68)	(1.05)
Eastern Archaic	Male	2	Mean	65.20	57.00	15.50	34.38	43.43	20.03	8.62	104.6	26.72	97.73	17.97
			(SD)	(0.99)	(0.00)	(0.71)	(2.24)	(0.46)	(0.67)	(0.12)	(3.84)	(1.53)	(0.68)	(1.05)
Eastern Archaic	Female	2	Mean	60.80	52.98	10.50	32.65	39.39	17.33	8.31	97.75	28.00	97.60	19.07
			(SD)	(3.68)	(0.00)	(2.12)	(0.21)	(5.32)	(0.38)	(0.21)	(10.3)	(1.41)	(4.81)	(0.09)
Woodland	Male	4	Mean	65.63	51.95	12.88	36.24	41.62	21.27	6.96	101.7	24.65	100.6	18.98
			(SD)	(2.56)	(3.04)	(2.46)	(1.51)	(2.13)	(1.93)	(1.27)	(3.56)	(1.92)	(5.00)	(3.48)
Woodland	Female	2	Mean	60.85	51.30	10.35	33.42	37.53	19.63	7.43	95.05	25.50	93.60	18.00
			(SD)	(2.33)	(0.28)	(5.02)	(0.33)	(0.81)	(2.64)	(0.74)	(2.90)	(0.57)	(0.57)	(1.70)
Late Woodland	Male	11	Mean	65.39	53.32	13.42	35.24	42.27	19.92	8.04	103.5	25.33	100.4	19.25
			(SD)	(2.62)	(2.88)	(1.94)	(1.38)	(2.02)	(1.79)	(1.34)	(4.09)	(2.14)	(3.27)	(3.66)
Late Woodland	Female	4	Mean	65.68	53.28	12.05	36.03	39.98	20.14	7.67	96.00	25.53	94.95	17.13
			(SD)	(2.61)	(3.54)	(4.86)	(1.25)	(3.33)	(0.36)	(1.73)	(7.14)	(1.84)	(3.89)	(2.17)
Sonota	Male	6	Mean	67.17	54.00	10.83	35.17	40.33	22.83	8.58	104.8	25.17	100.8	18.67
			(SD)	(3.06)	(3.52)	(1.94)	(2.14)	(1.97)	(1.94)	(0.81)	(2.71)	(4.12)	(1.72)	(2.94)
Sonota	Female	4	Mean	64.00	51.5 0	11.25	35.25	40.00	22.00	9.53	98.75	24.75	97.75	17.75
			(SD)	(3.56)	(3.00)	(2.87)	(1.26)	(1.41)	(1.83)	(1.89)	(8.46)	(2.36)	(3.78)	(2.50)
Arvilla, North	Male	8	Mean	65.47	55.26	12.84	35.59	41.00	20.22	7.26	101.5	24.76	98.61	18.18
			(SD)	(3.26)	(2.75)	(1.41)	(2.38)	(2.61)	(3.26)	(1.47)	(2.92)	(0.95)	(3.68)	(1.51)
Arvilla, North	Female	11	Mean	61.68	53.01	11.73	34.57	40.08	19.63	7.19	94.04	23.15	96.12	18.06
			(SD)	(2.93)	(0.74)	(1.49)	(1.52)	(2.19)	(3.00)	(1.64)	(5.46)	(1.57)	(4.49)	(2.23)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	MAB	MAL	MBD	OBH	OBB	DKB	WNB	ZMB	SSS	FMB	NAS
Arvilla, South	Male	12	Mean	63.83	53.58	11.75	35.42	41.00	21.29	8.55	102.8	25.67	99.50	17.83
			(SD)	(2.73)	(1.93)	(1.29)	(1.93)	(1.76)	(2.14)	(2.06)	(4.56)	(2.31)	(2.97)	(2.48)
Arvilla, South	Female	13	Mean	62.07	52.69	9.62	33.54	38.92	21.23	8.62	95.39	24.62	94.54	18.08
			(SD)	(2.66)	(3.99)	(1.76)	(1.85)	(1.94)	(1.48)	(1.79)	(3.36)	(3.10)	(3.69)	(1.75)
Devils Lake-Souris.	Male	10	Mean	66.135	53.34	12.42	35.62	42.73	21.14	7.61	103.1	24.52	101.3	19.99
			(SD)	(4.72)	(2.92)	(2.23)	(1.46)	(2.67)	(3.36)	(2.03)	(1.99)	(2.51)	(4.38)	(2.81)
Devils Lake-Souris.	Female	9	Mean	61.89	53.59	10.62	33.39	40.57	21.03	8.45	96.98	24.84	97.51	17.41
			(SD)	(3.20)	(1.86)	(1.19)	(1.80)	(1.88)	(2.86)	(1.53)	(5.65)	(2.50)	(2.62)	(1.97)
Blackduck, North	Male	19	Mean	64.88	56.30	13.69	33.81	42.30	21.37	9.45	100.3	26.76	101.5	18.53
			(SD)	(3.89)	(3.77)	(2.16)	(2.11)	(2.50)	(3.53)	(2.13)	(4.00)	(2.17)	(3.95)	(3.82)
Blackduck, North	Female	8	Mean	62.73	53.95	12.01	32.78	40.61	19.78	9.47	97.09	25.51	98.31	18.48
			(SD)	(2.26)	(1.44)	(2.44)	(3.64)	(2.76)	(2.14)	(2.44)	(4.10)	(2.37)	(2.59)	(1.48)
Blackduck, South	Male	14	Mean	62.29	54.42	13.13	34.67	40.49	21.36	8.89	100.8	25.33	99.22	19.24
			(SD)	(5.32)	(3.10)	(2.08)	(1.80)	(1.58)	(1.70)	(1.86)	(3.66)	(1.98)	(3.41)	(1.69)
Blackduck South	Female	5	Mean	62.91	50.42	12.15	32.98	40.05	19.96	8.54	93.04	23.85	95.99	18.14
			(SD)	(12.81)	(3.59)	(1.47)	(1.70)	(1.87)	(0.94)	(0.82)	(4.64)	(0.78)	(1.71)	(1.89)
Great Oasis	Male	2	Mean	67.50	55.00	14.00	35.00	41.50	23.50	9.65	102.0	26.50	102.0	17.00
			(SD)	(0.71)	(2.83)	(1.41)	(4.24)	(2.12)	(2.12)	(0.07)	(2.83)	(3.54)	(2.83)	(2.83)
Great Oasis	Female	5	Mean	68.00	55.60	10.20	34.20	39.80	21.40	9.14	99.00	24.40	96.80	17.40
			(SD)	(4.90)	(1.34)	(1.48)	(2.17)	(1.30)	(2.07)	(1.54)	(7.52)	(1.82)	(3.56)	(1.52)
Cambria	Male	1	Mean	65.90	57.00	15.00	32.22	42.40	19.21	8.65	99.00	27.50	99.10	21.50
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Big Stone	Male	5	Mean	65.54	54.33	11.34	33.99	42.43	19.62	7.85	99.76	25.42	98.76	19.80
			(SD)	(5.00)	(1.86)	(1.66)	(2.58)	(2.69)	(2.96)	(1.84)	(2.79)	(3.35)	(3.63)	(1.92)
Big Stone	Female	4	Mean	66.42	57.37	12.43	33.93	40.92	19.61	7.30	99.55	27.88	96.60	19.48
			(SD)	(3.60)	(3.08)	(2.14)	(2.76)	(2.61)	(2.36)	(1.33)	(4.31)	(1.92)	(2.18)	(1.72)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	MAB	MAL	MBD	OBH	OBB	DKB	WNB	ZMB	SSS	FMB	NAS
Mill Creek	Male	3	Mean	67.00	50.33	10.67	35.00	40.33	22.00	8.20	100.3	26.67	99.67	16.33
			(SD)	(5.20)	(4.73)	(1.16)	(2.00)	(1.16)	(2.65)	(1.18)	(3.79)	(3.06)	(3.51)	(3.06)
Mill Creek	Female	1	Mean	57.00	52.00	9.00	35.00	40.00	18.00	6.70	93.00	27.00	93.00	15.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Vermillion Bluff	Male	1	Mean	63.00	48.00	13.00	35.00	39.00	21.00	8.30	99.00	24.00	100.0	16.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Blue Earth	Male	6	Mean	64.28	52.67	12.17	34.47	39.65	20.20	8.54	99.27	26.07	98.92	19.08
			(SD)	(2.38)	(1.84)	(1.72)	(1.46)	(3.22)	(1.42)	(1.10)	(3.66)	(2.99)	(2.40)	(2.65)
Blue Earth	Female	2	Mean	62.87	50.49	12.05	34.88	41.75	19.98	8.15	93.50	24.00	95.00	20.40
			(SD)	(0.00)	(3.52)	(1.34)	(1.03)	(0.01)	(4.56)	(2.26)	(0.71)	(0.00)	(0.00)	(4.95)
Orr	Male	6	Mean	64.24	55.47	13.00	34.78	44.20	20.52	8.29	99.76	26.12	101.9	18.32
			(SD)	(3.09)	(2.24)	(1.48)	(1.60)	(3.38)	(2.94)	(0.42)	(6.26)	(2.52)	(5.14)	(2.31)
Orr	Female	7	Mean	59.27	53.87	10.90	33.07	40.33	19.36	9.57	94.53	23.27	94.36	17.11
			(SD)	(4.20)	(4.70)	(0.86)	(1.45)	(1.64)	(1.95)	(1.51)	(4.16)	(3.05)	(2.29)	(1.94)
Silvernale	Female	2	Mean	73.55	57.50	14.00	32.53	42.78	19.93	8.33	108.1	28.60	102.9	19.30
			(SD)	(4.74)	(1.41)	(0.71)	(2.14)	(1.10)	(1.24)	(0.12)	(2.76)	(0.85)	(1.06)	(0.28)
Assiniboine	Male	4	Mean	63.36	52.39	12.35	35.21	43.35	19.06	8.68	100.2	24.89	99.85	21.13
			(SD)	(2.23)	(1.97)	(0.44)	(1.56)	(2.27)	(2.17)	(1.79)	(7.15)	(2.78)	(0.81)	(2.66)
Assiniboine	Female	4	Mean	64.25	52.88	11.13	36.03	42.19	19.95	8.93	100.9	22.00	100.1	17.75
			(SD)	(1.26)	(2.78)	(2.66)	(2.13)	(1.99)	(3.83)	(2.62)	(4.87)	(4.08)	(4.21)	(2.06)
Cheyenne	Male	16	Mean	66.56	55.19	12.44	34.00	39.81	23.94	8.80	105.1	24.50	101.9	18.38
			(SD)	(3.48)	(4.15)	(1.86)	(1.86)	(2.01)	(1.88)	(1.54)	(5.20)	(3.16)	(3.70)	(3.63)
Cheyenne	Female	6	Mean	63.50	52.33	10.00	33.83	36.50	21.67	7.98	98.00	22.83	95.17	17.00
			(SD)	(2.51)	(5.28)	(2.76)	(1.72)	(1.52)	(1.37)	(1.26)	(4.86)	(3.71)	(5.12)	(1.55)
Cree	Male	1	Mean	62.84	53.50	9.10	28.50	43.55	20.27	7.60	98.20	23.00	100.8	20.60
			(SD)	.	.	.	.	.	.	.	.	.	.	.

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	MAB	MAL	MBD	OBH	OBB	DKB	WNB	ZMB	SSS	FMB	NAS
Ojibwa	Male	11	Mean	66.27	54.52	13.35	34.92	44.13	20.01	7.25	101.6	24.84	102.0	19.10
			(SD)	(2.09)	(1.76)	(3.01)	(1.17)	(1.99)	(3.51)	(2.15)	(2.39)	(1.17)	(3.21)	(1.91)
Ojibwa	Female	5	Mean	62.95	53.00	10.68	33.77	42.78	16.95	7.33	93.38	24.11	96.50	18.58
			(SD)	(0.67)	(1.23)	(0.25)	(1.84)	(1.91)	(2.84)	(1.01)	(2.36)	(0.55)	(2.53)	(2.66)
Mdewakanton	Male	1	Mean	60.60	51.50	17.00	34.84	40.80	13.50	8.53	97.00	23.00	91.10	13.50
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Oglala	Male	5	Mean	65.21	45.80	13.62	36.53	46.62	18.95	9.76	106.8	25.96	102.0	20.40
			(SD)	(2.34)	(3.52)	(3.15)	(3.07)	(2.48)	(2.05)	(2.38)	(3.85)	(2.73)	(3.31)	(3.12)
Oglala	Female	6	Mean	64.65	54.58	9.72	35.15	42.59	19.13	8.26	97.90	24.66	97.87	19.92
			(SD)	(1.87)	(2.17)	(1.47)	(2.08)	(1.05)	(1.90)	(0.79)	(3.47)	(3.33)	(1.95)	(5.38)
Santee	Male	4	Mean	67.25	55.14	12.25	34.50	43.25	20.25	9.45	104.5	25.00	101.8	20.50
			(SD)	(3.50)	(0.61)	(0.96)	(1.73)	(2.22)	(2.63)	(1.22)	(1.29)	(2.94)	(4.03)	(1.00)
Santee	Female	6	Mean	64.23	51.99	10.83	33.78	42.93	17.32	8.32	96.32	24.83	96.37	18.33
			(SD)	(4.03)	(2.36)	(3.71)	(2.08)	(1.29)	(1.76)	(1.96)	(4.62)	(3.66)	(4.10)	(1.63)
Sisseton-Wahpeton	Female	3	Mean	65.83	55.67	10.00	35.00	40.90	20.11	9.34	95.70	24.27	95.87	19.33
			(SD)	(0.76)	(2.52)	(1.73)	(1.73)	(0.22)	(0.96)	(1.56)	(2.86)	(2.02)	(1.03)	(0.58)
Teton	Male	6	Mean	67.31	54.10	12.08	36.17	41.33	22.33	8.79	105.3	22.51	103.8	18.86
			(SD)	(4.47)	(1.12)	(1.11)	(2.04)	(4.13)	(1.75)	(0.74)	(5.17)	(3.63)	(4.67)	(1.73)
Teton	Female	4	Mean	61.25	55.00	10.66	35.50	39.50	22.75	9.61	100.3	24.75	99.25	18.00
			(SD)	(2.87)	(2.71)	(2.06)	(2.38)	(0.58)	(3.78)	(1.12)	(2.63)	(2.06)	(5.06)	(3.56)
Yankton	Male	4	Mean	66.75	54.50	12.00	35.75	43.00	22.00	7.75	98.25	23.00	102.8	20.50
			(SD)	(2.22)	(1.29)	(2.94)	(1.50)	(2.00)	(2.83)	(1.17)	(2.06)	(3.27)	(3.59)	(2.52)
Siouan	Male	15	Mean	67.87	55.90	12.07	36.17	41.89	22.32	8.85	103.8	23.88	102.9	19.65
			(SD)	(2.77)	(3.06)	(1.90)	(1.94)	(1.59)	(2.84)	(2.22)	(4.67)	(2.74)	(4.89)	(1.55
Siouan	Female	8	Mean	63.88	52.13	9.50	34.75	39.63	21.75	8.14	98.88	23.63	97.63	18.38
			(SD)	(2.10)	(2.80)	(2.33)	(2.77)	(1.77)	(1.91)	(2.32)	(4.26)	(2.39)	(4.75)	(2.77)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	MAB	MAL	MBD	OBH	OBB	DKB	WNB	ZMB	SSS	FMB	NAS
Winnebago	Male	2	Mean	65.83	57.40	11.00	34.85	43.22	20.31	6.03	103.8	27.15	102.5	18.90
			(SD)	(0.00)	(0.71)	(1.41)	(1.97)	(2.50)	(2.55)	(0.33)	(1.06)	(0.07)	(7.71)	(2.55)
Winnebago	Female	1	Mean	62.87	51.00	11.50	32.06	41.14	18.70	9.36	90.50	23.00	97.00	17.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	IML	XML	MLS	WMH	SOS	GLS	FRC	FRS	FRF	PAC	PAS
Paleoindian	Male	1	Mean	36.00	49.00	10.10	21.60	6.00	5.10	112.90	21.00	53.6	113.20	23.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Early Archaic	Female	1	Mean	27.20	46.10	9.00	24.00	4.000	2.00	104.20	22.10	45.10	107.20	20.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Prairie Archaic	Male	3	Mean	36.18	55.58	11.30	27.80	6.13	3.30	111.27	22.33	50.30	111.17	21.97
			(SD)	(2.78)	(1.26)	(0.80)	(1.08)	(1.31)	(1.044	(3.61)	(3.98)	(0.92)	(4.44)	(2.68)
Eastern Archaic	Male	2	Mean	36.48	53.32	11.81	30.30	5.50	2.05	114.25	25.55	52.18	112.37	21.89
			(SD)	(1.38)	(2.57)	(0.28)	(5.94)	(0.71)	(1.34)	(6.01)	(3.75)	(1.87)	(3.73)	(1.12)
Eastern Archaic	Female	2	Mean	36.25	52.89	10.74	21.60	4.00	2.00	105.75	20.35	47.15	110.95	22.60
			(SD)	(1.77)	(1.58)	(0.37)	(0.00)	(0.00)	(0.00)	(1.77)	(2.33)	(2.62)	(1.49)	(0.99)
Woodland	Male	4	Mean	38.88	54.32	10.56	23.93	6.80	2.73	110.50	24.43	50.85	106.83	28.15
			(SD)	(2.82)	(2.19)	(1.24)	(2.13)	(2.16)	(1.23)	(1.92)	(1.28)	(6.60)	(3.95)	(16.06
Woodland	Female	2	Mean	37.45	55.50	8.90	24.35	5.50	2.05	104.55	22.05	48.60	110.50	23.05
			(SD)	(3.47)	(0.85)	(0.14)	(0.78)	(0.71)	(1.49)	(0.78)	(1.20)	(0.71)	(0.71)	(2.90)
Late Woodland	Male	1	Mean	38.13	55.61	11.53	25.70	4.97	3.34	107.46	22.49	49.85	111.52	22.59
		1	(SD)	(2.36)	(2.43)	(1.66)	(2.24)	(0.63)	(0.74)	(5.29)	(3.38)	(3.52)	(4.18)	(2.83)
Late Woodland	Female	4	Mean	34.35	51.38	9.85	24.35	3.45	1.68	107.13	22.60	49.30	111.33	24.98
			(SD)	(1.29)	(3.14)	(2.76)	(3.56)	(1.05)	(1.17)	(4.78)	(0.90)	(5.08)	(3.65)	(0.86)
Sonota	Male	6	Mean	38.83	57.67	10.33	26.17	7.17	4.33	108.00	22.33	51.67	105.96	21.28
			(SD)	(1.84)	(2.88)	(3.01)	(2.04)	(0.98)	(1.03)	(5.55)	(2.07)	(8.31)	(6.16)	(3.05)
Sonota	Female	4	Mean	36.75	54.25	10.25	24.75	4.25	2.75	107.50	23.00	47.50	105.25	22.00
			(SD)	(2.50)	(3.30)	(2.75)	(2.06)	(0.96)	(1.50)	(5.32)	(1.83)	(4.36)	(7.93)	(2.83)
Arvilla, North	Male	8	Mean	37.64	53.73	10.63	26.03	6.34	3.34	108.25	21.54	48.41	108.13	22.60
			(SD)	(4.61)	(2.85)	(1.84)	(1.65)	(1.35)	(1.32)	(3.87)	(1.84)	(2.93)	(5.68)	(2.90)
Arvilla, North	Female	1	Mean	35.07	52.49	9.77	22.95	4.41	1.68	106.60	23.47	46.56	109.26	22.26
		1	(SD)	(2.17)	(2.21)	(1.56)	(2.02)	(1.14)	(0.72)	(3.95)	(2.29)	(2.85)	(4.74)	(2.56)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	IML	XML	MLS	WMH	SOS	GLS	FRC	FRS	FRF	PAC	PAS
Arvilla, South	Male	1	Mean	36.83	55.08	9.67	24.83	6.17	3.42	110.50	22.25	50.83	111.67	23.17
		2	(SD)	(3.07)	(3.53)	(1.16)	(1.80)	(1.12)	(1.00)	(4.98)	(2.77)	(4.69)	(3.63)	(2.68)
Arvilla, South	Female	1	Mean	36.00	51.98	10.27	23.46	4.77	1.69	106.92	22.23	45.31	108.85	22.08
		3	(SD)	(3.06)	(3.00)	(1.64)	(1.89)	(1.01)	(0.63)	(3.59)	(2.46)	(2.18)	(7.14)	(3.17)
Devils Lake-Souris.	Male	1	Mean	38.39	54.23	10.82	25.05	6.11	4.02	113.42	22.67	53.44	106.93	20.51
		0	(SD)	(4.45)	(3.04)	(1.54)	(1.49)	(0.93)	(0.67)	(4.54)	(1.99)	(4.53)	(6.96)	(2.59)
Devils Lake-Souris.	Female	9	Mean	35.33	52.08	10.48	21.79	4.54	1.99	109.28	24.39	48.99	108.89	22.56
			(SD)	(2.17)	(3.14)	(1.93)	(4.23)	(1.34)	(0.85)	(4.51)	(2.73)	(2.94)	(4.43)	(2.30)
Blackduck, North	Male	1	Mean	36.89	56.33	11.50	24.67	6.05	3.44	112.64	22.95	51.01	112.32	22.97
		9	(SD)	(3.31)	(3.66)	(1.06)	(2.85)	(0.90)	(1.76)	(3.83)	(2.39)	(3.87)	(5.54)	(2.19)
Blackduck, North	Female	8	Mean	35.24	52.65	10.56	22.54	5.28	2.51	108.61	22.44	49.01	108.23	21.68
			(SD)	(3.34)	(2.99)	(0.51)	(1.49)	(2.06)	(0.96)	(3.29)	(1.80)	(2.85)	(7.64)	(3.96)
Blackduck, South	Male	1	Mean	36.75	51.98	10.95	24.01	6.09	2.66	110.59	22.54	49.58	111.17	22.50
		4	(SD)	(3.64)	(3.27)	(1.89)	(2.27)	(1.64)	(1.04)	(4.81)	(2.58)	(4.70)	(4.87)	(1.76)
Blackduck South	Female	5	Mean	33.18	49.71	10.22	24.32	4.90	2.46	106.42	23.04	48.34	103.02	19.20
			(SD)	(2.36)	(3.93)	(2.03)	(2.09)	(0.55)	(1.00)	(7.72)	(2.60)	(2.61)	(8.12)	(4.39)
Great Oasis	Male	2	Mean	37.50	53.50	10.00	25.00	7.50	5.00	116.50	23.00	60.00	109.00	24.00
			(SD)	(3.54)	(0.71)	(1.41)	(0.00)	(0.71)	(1.41)	(4.95)	(1.41)	(4.24)	(16.97	(1.41)
Great Oasis	Female	5	Mean	37.00	53.40	11.20	24.00	5.60	2.40	107.00	22.20	47.20	104.80	23.00
			(SD)	(2.45)	(3.85)	(1.10)	(2.00)	(1.14)	(0.89)	(5.05)	(1.92)	(3.96)	(5.89)	(1.87)
Cambria	Male	1	Mean	38.00	56.50	9.90	22.50	8.00	4.00	112.10	21.90	49.50	112.00	23.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Big Stone	Male	5	Mean	38.30	56.30	12.24	23.88	6.96	3.20	106.42	21.14	47.52	105.74	21.02
			(SD)	(3.49)	(2.66)	(2.26)	(1.26)	(1.03)	(1.10)	(2.77)	(1.95)	(2.57)	(8.65)	(2.32)
Big Stone	Female	4	Mean	35.88	56.45	11.60	21.98	4.18	2.38	110.63	23.30	48.23	111.90	24.03
			(SD)	(1.35)	(0.42)	(1.62)	(1.46)	(0.67)	(0.75)	(2.50)	(2.45)	(2.78)	(3.71)	(1.32)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	IML	XML	MLS	WMH	SOS	GLS	FRC	FRS	FRF	PAC	PAS
Mill Creek	Male	3	Mean	37.33	53.67	11.00	24.00	5.67	3.33	111.33	24.00	56.00	107.67	22.33
			(SD)	(0.58)	(1.53)	(2.00)	(1.00)	(0.58)	(0.58)	(5.86)	(2.65)	(8.72)	(2.08)	(2.08)
Mill Creek	Female	1	Mean	32.00	48.00	8.00	18.00	4.00	2.00	100.00	23.00	48.00	93.00	19.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Vermillion Bluff	Male	1	Mean	35.00	53.00	9.00	27.00	7.00	4.00	110.00	22.00	56.00	103.00	26.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.
Blue Earth	Male	6	Mean	35.28	54.60	11.17	24.35	6.72	3.07	110.02	22.13	48.27	109.32	23.28
			(SD)	(4.08)	(2.31)	(2.32)	(2.10)	(1.69)	(1.08)	(4.05)	(1.53)	(2.47)	(4.10)	(2.15)
Blue Earth	Female	2	Mean	31.50	48.39	9.79	21.25	5.25	2.50	109.25	24.00	51.80	107.50	23.45
			(SD)	(4.95)	(4.79)	(0.98)	(2.48)	(1.77)	(0.85)	(2.48)	(5.66)	(3.25)	(0.00)	(2.19)
Orr	Male	6	Mean	37.43	54.81	13.00	24.80	7.85	4.48	112.53	21.42	51.13	109.62	22.92
			(SD)	(2.64)	(3.92)	(1.91)	(3.07)	(2.37)	(1.48)	(6.36)	(1.46)	(7.19)	(4.48)	(2.36)
Orr	Female	7	Mean	33.46	49.36	10.29	21.56	4.63	1.27	105.49	23.31	46.01	103.57	22.66
			(SD)	(2.42)	(1.24)	(0.99)	(2.16)	(0.92)	(0.68)	(5.51)	(2.44)	(2.77)	(4.37)	(2.25)
Silvernale	Female	2	Mean	41.40	63.50	13.10	29.50	6.05	4.75	111.05	20.00	55.75	112.55	21.55
			(SD)	(2.40)	(0.85)	(0.14)	(3.18)	(1.49)	(1.77)	(3.61)	(1.41)	(3.89)	(7.85)	(3.61)
Assiniboine	Male	4	Mean	34.95	54.88	11.30	24.35	5.63	3.00	106.75	21.88	49.83	108.53	23.03
			(SD)	(2.13)	(3.22)	(1.55)	(1.88)	(0.95)	(0.82)	(0.50)	(1.03)	(3.80)	(1.71)	(2.11)
Assiniboine	Female	4	Mean	34.28	51.88	11.00	24.53	4.25	2.00	109.53	25.28	48.53	106.50	21.23
			(SD)	(1.25)	(2.39)	(1.16)	(1.72)	(1.71)	(0.82)	(5.54)	(2.97)	(1.89)	(3.70)	(1.46)
Cheyenne	Male	16	Mean	36.56	57.31	11.75	24.38	6.25	2.88	110.81	23.44	50.56	112.19	24.31
			(SD)	(3.54)	(3.79)	(1.39)	(2.16)	(1.18)	(1.26)	(5.27)	(2.66)	(3.65)	(5.18)	(2.65)
Cheyenne	Female	6	Mean	32.50	51.33	11.00	22.67	3.17	1.83	104.33	22.00	47.17	106.00	21.50
			(SD)	(5.75)	(3.27)	(1.67)	(2.16)	(0.75)	(0.75)	(2.66)	(2.28)	(3.60)	(4.29)	(0.55)
Cree	Male	1	Mean	36.00	51.00	11.00	22.00	7.50	2.00	106.79	23.02	47.21	103.20	20.00
			(SD)	.	.	.	.	.	.	.	.	.	.	.

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	IML	XML	MLS	WMH	SOS	GLS	FRC	FRS	FRF	PAC	PAS
Ojibwa	Male	1 1	Mean (SD)	37.97 (2.50)	65.08 (3.59)	12.03 (1.51)	25.15 (1.31)	5.60 (1.33)	3.84 (1.07)	111.91 (4.70)	23.77 (2.82)	50.75 (2.82)	108.22 (6.36)	21.75 (2.91)
Ojibwa	Female	5	Mean (SD)	36.42 (1.49)	51.75 (1.79)	11.33 (0.82)	22.21 (1.11)	4.21 (1.15)	2.23 (0.44)	104.22 (1.75)	21.58 (1.68)	45.32 (4.27)	100.34 (3.05)	20.42 (2.70)
Mdewakanton	Male	1	Mean (SD)	33.00 .	47.10 .	12.8 .	23.50 .	5.20 .	3.50 .	112.00 .	27.10 .	48.10 .	108.10 .	26.10 .
Oglala	Male	5	Mean (SD)	36.24 (2.30)	53.76 (2.41)	11.42 (1.47)	24.06 (2.06)	5.40 (0.87)	2.62 (1.84)	110.74 (3.36)	23.40 (2.46)	49.26 (2.95)	104.92 (1.48)	20.24 (2.90)
Oglala	Female	6	Mean (SD)	35.25 (3.59)	53.97 (2.28)	11.52 (1.43)	23.48 (1.45)	3.37 (0.83)	1.67 (1.03)	107.07 (1.15)	23.17 (0.82)	48.42 (2.04)	101.28 (4.61)	19.62 (2.34)
Santee	Male	4	Mean (SD)	38.50 (2.65)	47.75 (7.68)	10.00 (3.46)	31.25 (8.66)	4.75 (0.96)	3.00 (0.82)	111.00 (3.92)	22.00 (1.63)	48.50 (3.32)	106.50 (1.73)	22.75 (2.06)
Santee	Female	6	Mean (SD)	35.43 (3.03)	48.02 (5.47)	9.08 (3.01)	24.85 (5.66)	3.92 (1.20)	2.08 (0.67)	107.83 (3.92)	23.50 (1.87)	45.08 (4.82)	103.68 (2.89)	21.65 (1.95)
Sisseton-Wahpeton	Female	3	Mean (SD)	35.27 (1.62)	49.00 (6.06)	9.80 (1.97)	23.73 (2.61)	4.63 (0.55)	1.53 (0.84)	108.73 (5.66)	23.33 (2.52)	44.70 (4.42)	107.73 (6.37)	20.87 (3.49)
Teton	Male	6	Mean (SD)	39.00 (1.67)	56.33 (3.93)	11.33 (1.37)	25.50 (3.56)	7.33 (1.63)	3.50 (2.07)	111.83 (2.71)	23.50 (1.73)	49.67 (3.14)	107.17 (5.64)	21.50 (1.76)
Teton	Female	4	Mean (SD)	36.00 (1.83)	51.94 (2.45)	10.87 (0.86)	24.73 (1.73)	3.75 (0.96)	1.75 (0.50)	109.00 (2.94)	23.25 (2.22)	50.50 (3.11)	103.25 (4.35)	19.25 (1.71)
Yankton	Male	4	Mean (SD)	40.75 (2.06)	56.25 (1.71)	10.00 (0.82)	24.50 (1.73)	5.00 (1.41)	2.25 (1.26)	111.50 (2.38)	24.50 (2.65)	55.75 (4.11)	107.50 (4.20)	21.75 (2.87)
Siouan	Male	1 5	Mean (SD)	38.83 (3.34)	57.47 (4.17)	11.54 (1.69)	25.53 (1.81)	6.20 (2.01)	3.19 (1.14)	112.80 (3.47)	23.55 (1.68)	51.17 (4.82)	108.63 (8.72)	22.91 (3.74)
Siouan	Female	8	Mean (SD)	34.13 (2.36)	52.75 (3.24)	10.50 (1.93)	22.88 (1.96)	4.75 (1.49)	1.75 (1.04)	106.63 (4.17)	22.50 (2.61)	45.00 (2.00)	101.00 (7.43)	19.00 (3.12)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	IML	XML	MLS	WMH	SOS	GLS	FRC	FRS	FRF	PAC	PAS
Winnebago	Male	2	Mean (SD)	36.50 (0.57)	52.60 (0.00)	11.00 (0.71)	23.85 (2.62)	6.25 (1.77)	4.50 (0.71)	112.55 (5.02)	23.00 (4.38)	52.70 (1.70)	104.00 (6.93)	23.40 (6.36)
Winnebago	Female	1	Mean (SD)	35.10 .	47.00 .	12.10 .	20.80 .	5.00 .	1.50 .	99.00 .	21.90 .	40.10 .	111.10 .	25.10 .

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	PAF	OCC	OCS	OCF	FOB	EKR	LAR	BAR
Paleoindian	Male	1	Mean	56.20	95.79	29.22	45.86	31.37	80.50	113.00	115.06
			(SD)	.	.	.	.	.	.	.	.
Early Archaic	Female	1	Mean	55.90	93.50	29.00	45.60	31.00	69.80	107.50	14.03
			(SD)	.	.	.	.	.	.	.	.
Prairie Archaic	Male	3	Mean	53.47	104.53	31.63	53.50	31.16	74.37	110.90	22.67
			(SD)	(3.04)	(5.03)	(0.55)	(10.0)	(2.06)	(4.484	(1.64)	(4.01)
Eastern Archaic	Male	2	Mean	52.17	94.30	28.60	43.50	28.80	75.75	111.85	10.55
			(SD)	(4.34)	(1.70)	(0.71)	(3.54)	(2.40)	(3.18)	(0.21)	(5.73)
Eastern Archaic	Female	2	Mean	55.60	96.50	32.00	42.05	31.90	79.90	106.50	15.05
			(SD)	(3.39)	(0.71)	(1.41)	(4.17)	(1.56)	(10.0)	(1.41)	(0.64)
Woodland	Male	4	Mean	55.08	96.57	30.06	48.08	31.54	77.18	103.08	16.64
			(SD)	(3.00)	(4.93)	(1.90)	(4.28)	(1.00)	(3.06)	(4.04)	(2.31)
Woodland	Female	2	Mean	61.10	94.05	28.72	45.09	29.65	74.75	100.80	15.37
			(SD)	(1.56)	(0.00)	(0.00)	(0.00)	(0.00)	(1.77)	(3.82)	(1.89)
Late Woodland	Male	11	Mean	57.73	93.88	30.07	45.64	31.87	76.00	104.50	19.12
			(SD)	(4.57)	(2.58)	(2.10)	(4.67)	(0.59)	(4.27)	(2.03)	(9.80)
Late Woodland	Female	4	Mean	56.65	93.86	26.16	40.05	31.81	74.40	105.08	15.08
			(SD)	(1.69)	(3.38)	(4.12)	(5.38)	(5.15)	(2.61)	(2.20)	(1.65)
Sonota	Male	6	Mean	56.37	98.47	33.20	47.81	30.06	77.00	102.60	22.33
			(SD)	(3.97)	(1.07)	(2.93)	(4.46)	(2.79)	(2.10)	(2.95)	(2.07)
Sonota	Female	4	Mean	53.50	95.00	29.25	45.50	29.50	72.00	103.25	16.25
			(SD)	(3.87)	(0.82)	(1.26)	(4.51)	(2.08)	(4.08)	(1.89)	(4.19)
Arvilla, North	Male	8	Mean	54.81	94.79	27.96	47.55	31.78	73.75	103.11	16.76
			(SD)	(5.72)	(4.31)	(2.12)	(4.76)	(0.78)	(3.29)	(2.52)	(2.70)
Arvilla, North	Female	11	Mean	55.32	91.78	28.66	44.44	31.17	73.53	100.68	13.15
			(SD)	(1.65)	(3.85)	(1.83)	(2.65)	(2.74)	(3.92)	(3.85)	(2.83)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	PAF	OCC	OCS	OCF	FOB	EKR	LAR	BAR
Arvilla, South	Male	12	Mean	59.67	98.08	31.42	46.92	31.03	74.67	104.50	13.76
			(SD)	(3.99)	(3.68)	(2.68)	(4.76)	(1.54)	(2.54)	(2.78)	(3.55)
Arvilla, South	Female	13	Mean	54.85	94:85	29.29	45.47	29.28	71.54	103.39	15.23
			(SD)	(6.72)	(4.36)	(3.97)	(5.53)	(2.32)	(2.54)	(2.79)	(3.83)
Devils Lake-Souris.	Male	10	Mean	53.64	95.43	31.37	45.69	30.34	74.50	105.86	14.67
			(SD)	(6.56)	(5.89)	(2.97)	(8.10)	(2.33)	(2.06)	(4.21)	(2.52)
Devils Lake-Souris.	Female	9	Mean	57.31	94.71	28.49	45.97	29.77	74.34	102.71	14.47
			(SD)	(4.23)	(4.20)	(2.11)	(3.15)	(1.70)	(5.20)	(3.81)	(2.50)
Blackduck, North	Male	19	Mean	58.11	97.83	29.02	47.71	31.59	75.51	106.24	16.03
			(SD)	(3.82)	(4.61)	(1.27)	(3.35)	(0.86)	(2.34)	(3.16)	(2.20)
Blackduck, North	Female	8	Mean	54.03	98.22	28.82	45.53	29.58	73.34	105.22	13.28
			(SD)	(2.65)	(5.66)	(0.37)	(4.21)	(2.22)	(2.28)	(4.50)	(2.85)
Blackduck, South	Male	14	Mean	55.98	96.23	28.68	47.64	32.25	74.95	105.15	15.48
			(SD)	(3.94)	(5.42)	(3.39)	(5.47)	(2.23)	(1.85)	(3.22)	(1.83)
Blackduck South	Female	5	Mean	49.92	95.99	30.80	47.92	28.63	71.72	105.46	13.03
			(SD)	(6.01)	(9.93)	(5.30)	(7.23)	(1.83)	(3.21)	(8.63)	(3.25)
Great Oasis	Male	2	Mean	58.50	99.50	27.50	48.50	30.50	75.00	107.00	19.00
			(SD)	(16.26	(9.19)	(2.12)	(0.71)	(0.71)	(5.66)	(9.90)	(1.41)
Great Oasis	Female	5	Mean	55.40	95.00	28.20	48.20	29.40	70.00	99.80	15.60
			(SD)	(5.32)	(1.58)	(2.68)	(6.06)	(1.34)	(2.12)	(6.83)	(1.82)
Cambria	Male	1	Mean	53.50	95.50	24.90	46.00	30.00	74.50	109.00	17.00
			(SD)	.	.	.	.	.	.	.	.
Big Stone	Male	5	Mean	47.00	99.26	27.64	45.08	31.94	73.39	106.24	17.59
			(SD)	(6.89)	(5.12)	(2.71)	(11.3)	(2.62)	(2.14)	(5.43)	(5.49)
Big Stone	Female	4	Mean	56.25	94.25	24.98	47.98	31.14	74.73	104.32	16.63
			(SD)	(5.54)	(1.29)	(3.14)	(6.33)	(1.63)	(2.50)	(2.41)	(3.36)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	PAF	OCC	OCS	OCF	FOB	EKR	LAR	BAR
Mill Creek	Male	3	Mean	48.67	103.33	30.00	53.00	30.00	73.67	105.67	18.67
			(SD)	(1.16)	(5.03)	(2.65)	(4.58)	(1.00)	(2.08)	(4.04)	(2.52)
Mill Creek	Female	1	Mean	40.00	90.00	27.00	54.00	28.00	69.00	89.00	9.00
			(SD)	.	.	.	.	.	.	.	.
Vermillion Bluff	Male	1	Mean	58.00	96.00	27.00	47.00	35.00	73.00	105.00	18.00
			(SD)	.	.	.	.	.	.	.	.
Blue Earth	Male	6	Mean	56.13	96.02	27.02	42.58	29.50	74.95	104.58	15.37
			(SD)	(3.22)	(4.70)	(4.10)	(3.57)	(2.07)	(3.74)	(4.63)	(3.09)
Blue Earth	Female	2	Mean	56.65	88.45	27.75	43.00	29.93	68.25	103.80	11.50
			(SD)	(3.47)	(1.06)	(0.35)	(0.39)	(0.39)	(6.01)	(0.28)	(2.12)
Orr	Male	6	Mean	52.68	97.10	26.72	47.22	31.12	73.46	107.87	13.88
			(SD)	(5.89)	(1.60)	(3.07)	(3.41)	(2.75)	(3.54)	(3.75)	(3.20)
Orr	Female	7	Mean	51.73	94.64	26.34	46.19	28.16	70.17	100.66	13.86
			(SD)	(3.81)	(5.22)	(3.05)	(5.83)	(2.26)	(4.37)	(5.21)	(3.77)
Silvernale	Female	2	Mean	55.75	100.50	27.60	49.85	29.55	77.25	106.75	20.05
			(SD)	(13.1)	(10.6)	(11.9)	(2.33)	(0.78)	(6.01)	(4.60)	(0.64)
Assiniboine	Male	4	Mean	52.90	95.05	30.60	44.60	30.50	72.43	104.10	15.93
			(SD)	(3.33)	(5.18)	(2.52)	(5.18)	(1.73)	(2.28)	(2.61)	(2.43)
Assiniboine	Female	4	Mean	55.53	97.03	30.75	44.73	30.28	73.63	106.88	10.75
			(SD)	(4.69)	(6.86)	(4.92)	(6.91)	(2.32)	(1.11)	(8.19)	(3.59)
Cheyenne	Male	16	Mean	54.75	93.31	27.31	43.50	30.94	72.88	103.00	15.19
			(SD)	(4.57)	(3.70)	(2.80)	(5.96)	(1.61)	(3.36)	(5.22)	(2.79)
Cheyenne	Female	6	Mean	54.50	90.83	25.50	40.17	29.17	68.50	97.17	14.17
			(SD)	(2.43)	(1.94)	(3.45)	(5.67)	(2.14)	(2.88)	(1.84)	(1.72)
Cree	Male	1	Mean	52.00	83.10	25.90	38.10	29.90	71.10	96.50	15.00
			(SD)	.	.	.	.	.	.	.	.

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	PAF	OCC	OCS	OCF	FOB	EKR	LAR	BAR
Ojibwa	Male	11	Mean	53.21	94.58	29.16	44.91	30.95	74.95	105.23	14.99
			(SD)	(6.13)	(4.61)	(2.40)	(6.14)	(2.02)	(3.66)	(3.94)	(2.78)
Ojibwa	Female	5	Mean	51.12	89.23	26.64	46.58	28.25	70.60	98.22	13.67
			(SD)	(2.50)	(4.22)	(1.76)	(4.17)	(2.14)	(1.67)	(2.35)	(1.00)
Mdewakanton	Male	1	Mean	51.30	86.20	23.20	36.10	29.10	72.00	99.00	21.00
			(SD)	.	.	.	.	.	.	.	.
Oglala	Male	5	Mean	48.82	92.32	29.88	42.76	33.90	73.00	99.68	14.86
			(SD)	(6.94)	(4.54)	(3.88)	(2.79)	(8.78)	(2.37)	(3.30)	(5.24)
Oglala	Female	6	Mean	52.22	93.93	33.35	44.48	30.86	72.85	101.75	15.22
			(SD)	(3.93)	(6.24)	(5.23)	(4.81)	(2.47)	(0.81)	(5.58)	(1.34)
Santee	Male	4	Mean	53.50	93.25	29.75	44.00	32.50	72.50	103.25	17.00
			(SD)	(4.04)	(2.63)	(2.99)	(4.08)	(1.29)	(5.00)	(3.10)	(1.16)
Santee	Female	6	Mean	50.33	94.08	29.67	39.60	29.50	72.02	100.62	13.83
			(SD)	(6.53)	(4.01)	(3.08)	(6.86)	(1.98)	(3.23)	(4.35)	(3.66)
Sisseton-Wahpeton	Female	3	Mean	53.70	95.33	31.53	43.17	28.38	71.57	104.40	14.40
			(SD)	(3.16)	(11.0)	(3.33)	(14.7)	(1.13)	(2.50)	(7.21)	(3.08)
Teton	Male	6	Mean	54.00	92.83	32.17	40.00	32.33	72.83	103.50	14.84
			(SD)	(7.38)	(5.19)	(5.67)	(6.72)	(2.73)	(1.94)	(4.51)	(3.00)
Teton	Female	4	Mean	52.00	96.00	29.75	46.00	26.00	71.23	103.02	12.51
			(SD)	(4.32)	(3.37)	(2.63)	(4.76)	(4.55)	(0.93)	(3.16)	(3.88)
Yankton	Male	4	Mean	58.25	89.00	27.50	40.25	33.00	72.50	99.00	14.50
			(SD)	(5.85)	(6.38)	(4.66)	(5.32)	(3.46)	(3.79)	(6.22)	(5.26)
Siouan	Male	15	Mean	57.13	93.78	28.62	43.34	31.57	74.00	103.57	13.37
			(SD)	(5.98)	(3.95)	(3.40)	(6.14)	(2.19)	(3.51)	(4.19)	(4.85)
Siouan	Female	8	Mean	51.75	94.00	31.25	45.13	29.00	69.13	101.25	12.00
			(SD)	(2.66)	(4.57)	(2.38)	(4.88)	(2.20)	(2.95)	(2.92)	(1.93)

Appendix 2-1 (continued).

Phase	Sex	N	Statistic	PAF	OCC	OCS	OCF	FOB	EKR	LAR	BAR
Winnebago	Male	2	Mean (SD)	58.10 (4.88)	91.05 (4.88)	22.75 (4.60)	44.10 (2.97)	32.00 (0.71)	71.60 (2.97)	99.05 (2.19)	12.25 (0.35)
Winnebago	Female	1	Mean (SD)	50.50 .	92.50 .	26.00 .	42.10 .	33.00 .	71.20 .	96.40 .	17.00 .

VITA

Susan M. T. Myster was born and raised in Minneapolis, Minnesota. She attended public schools in Brooklyn Park, a suburb of Minneapolis. In June of 1980 she graduated from Park Center High School. The following August she entered Hamline University and graduated Cum laude with honors in Anthropology, in May, 1984.

From May, 1984, through August, 1985, Susan worked as a research and field assistant in the Minnesota State Archaeologist's Office. In September, 1985, she entered graduate school at the University of Tennessee, Knoxville and began graduate work in Anthropology. After completing research on the trace element concentrations of a sample of Late Prehistoric human remains from Nashville, Susan received her Master of Arts degree in Anthropology in May, 1989. Upon completion of the Master's degree, Susan entered the Ph.D. program in the same department. In 1989, while completing the Ph.D. coursework, she received a summer fellowship to conduct skeletal research at the Smithsonian Institution.

In 1990, Susan was offered a job at Hamline University in St. Paul, Minnesota. She accepted the offer and returned to Minnesota to teach, conduct research on pre-Contact American Indian remains, and prepare the remains for repatriation and reburial. After several years Susan returned to the Ph.D. program and began her dissertation research. The doctoral degree was received in December, 2000.

Susan is currently employed by Hamline University, teaching full-time, researching past human populations from the Upper Midwest, and consulting as a Forensic Anthropologist. She is an Assistant Professor in the Department of Anthropology and Director of the Forensic Sciences Certificate program.